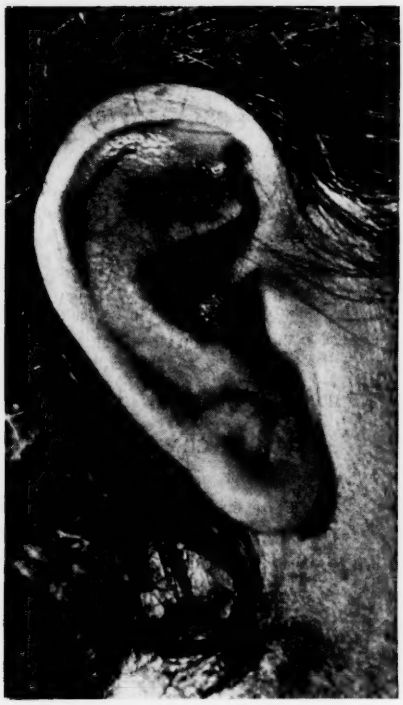
The Journal of HEREDITY



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Parenthood Attitudes of College Men

Reports on Three Sex-Control Experiments

Eugenics and Nutrition

Genetics—Chemistry—Cancer

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The Family-Counselling Movement

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The

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The **Journal** has obvious advantages as a supplementary text in genetics classes. Since genetics deals mainly with form and pattern differences in organisms the **Journal** offers an unexcelled introduction to current developments, which have an added interest and appeal on account of the large number of illustrations published.

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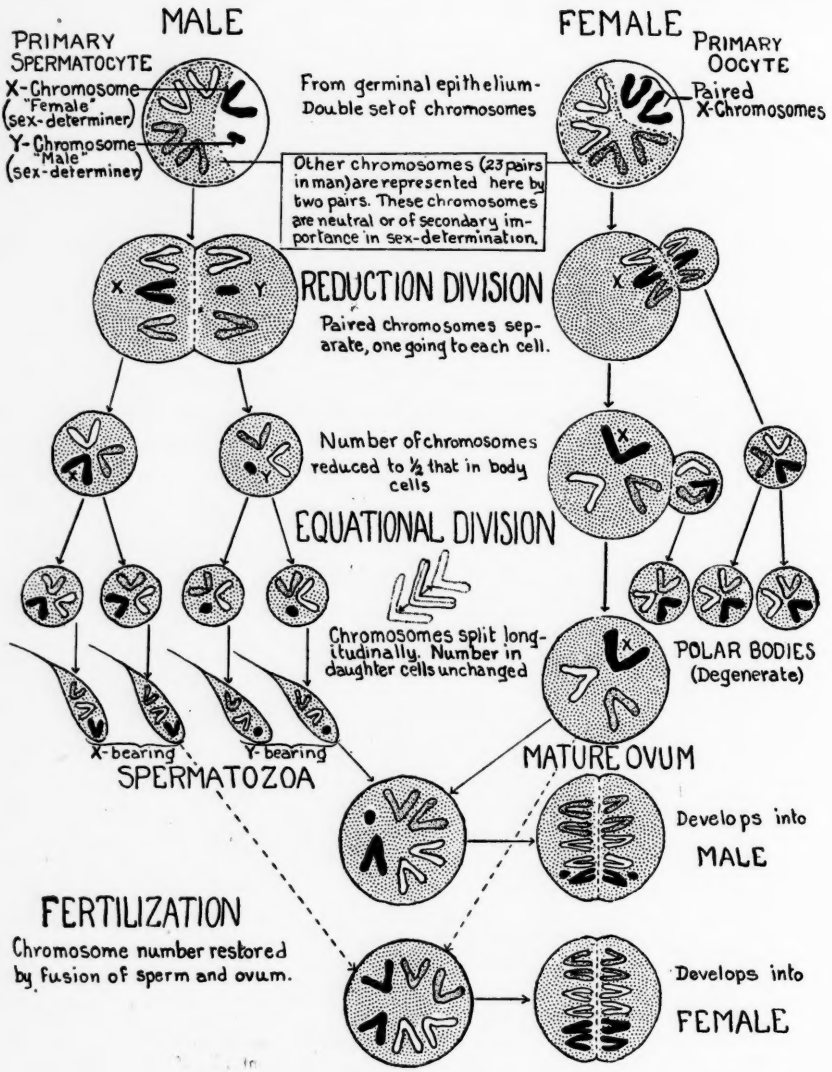

MALE
FEMALE
PRIMARY SPERMATOCYTE
X-Chromosome "Female" (sex-determiner)
Y-Chromosome "Male" (sex-determiner)
From germinal epithelium- Double set of chromosomes
PRIMARY OOCYTE
Paired X-Chromosomes
Other chromosomes (23 pairs in man) are represented here by two pairs. These chromosomes are neutral or of secondary importance in sex-determination.
REDUCTION DIVISION
Paired chromosomes separate, one going to each cell.
Number of chromosomes reduced to ½ that in body cells
EQUATIONAL DIVISION
Chromosomes split longitudinally. Number in daughter cells unchanged
POLAR BODIES (Degenerate)
X-bearing
Y-bearing
SPERMATOZOA
MATURE OVUM
Develops into MALE
FERTILIZATION
Chromosome number restored by fusion of sperm and ovum.
Develops into FEMALE

THE MECHANISM OF SEX-DETERMINATION

Frontispiece

Sex in mammals is normally determined by the so-called *X* and *Y* chromosomes, the spermatozoa being of two kinds with respect to these chromosomes. The Unterberger method of sex-determination alleges that the acidity or alkalinity of the medium in which the sperm find themselves affects the motility or the viability of one kind of sperm or the other. This assumption rests on, the at present conflicting observations of the sex-ratio at birth, because it is not possible to tell the two kinds of sperm apart by direct observation. (From Cole and Johansson, 1932.)

THE EFFECT OF LACTIC ACID AND SODIUM BICARBONATE ON THE SEX RATIO

E. ROBERTS
Department of Animal Husbandry, University of Illinois

NOTE: *The Editor closed a review of the New York News' experiment in sex determination in the April, 1940,* JOURNAL *on a note of skepticism. Reference was made to three independent experiments which it was hoped would permanently settle the merits of Unterberger's acid-alkali sex determination method. The results of these experiments were given to the world at a symposium of the American Society of Animal Production in Chicago on November 30, and are published herewith. A final evaluation of the method is impossible until the reasons for the conflicting results reported here are understood.*—EDITOR.

AFTER seeing a mimeographed report of the sex control experiments sponsored by The New York *Daily News* and carried on by the Applied Research Laboratories at Dayton, New Jersey, similar tests with rats were begun at the University of Illinois in October, 1939.* We attempted to use the same technique employed by the Applied Research Laboratories. During a visit of Mr. Durfee, director of the Laboratories, to our laboratory in December 1939, our methods were discussed and they seemed to be essentially similar to the methods employed in Mr. Durfee's laboratory. These methods are described in *Animal Sex Control* by Carl Warren, published by Orange Judd Publishing Company.

Results With Lactic Acid

Thirty-two litters were produced from matings in which 2% lactic acid was used, containing 111 males and 163 females. This is a sex ratio of 68.1 males to 100 females. Sixty-nine litters, following a treatment with 3% lactic acid contained 166 males and 301 females, a sex ratio of 55.1 males to 100 females. With most of these litters the treatment consisted of douching the vagina three times in immediate succession by means of a medicine dropper. All matings occurred within a period of two hours from the time of douching. We were unable, however, to aspirate the solutions in and out as given in the directions by the *News*.

Results With Sodium Bicarbonate

Both 3% and 5% solutions of sodium bicarbonate were used. With a 3% solution 35 litters were produced containing 157 males and 126 females, a sex ratio of 124.6 males to 100 females. With 5% sodium bicarbonate 70 litters were produced containing 366 males and 177 females, a sex ratio of 206.8 males to 100 females.

The combined results from both lactic acid treatments give 101 litters with 277 males and 464 females, a sex ratio of 59.7 males to 100 females. With both sodium bicarbonate treatments, 105 litters contained 523 males and 303 females, a sex ratio of 172.6 males to 100 females.

The results with both lactic acid and sodium bicarbonate treatments are given in Table I.

The increase in the strength of the lactic acid solution from 2% to 3%, and that of sodium bicarbonate from 3% to 5% may have slightly reduced litter size. Of this we cannot be sure however, because the animals were of different ages when litters were produced. To find out if the stronger solutions do reduce litter size, it would be desirable to have animals of the same age, treated and mated at the same time in order to have a reliable comparison.

*Acknowledgment is made to H. G. Kimpel, C. J. Rickher, V. Sprague, and U. S. Garrigus for technical assistance in this study.

Females Treated With Both Lactic Acid and Sodium Bicarbonate

In Table II are given the results of females producing litters from both kinds of treatments. With 2% lactic acid 11 litters with 98 young showed a sex ratio of 84.9 males to 100 females. The same females with 3% sodium bicarbonate had a sex ratio among 98 young of 127.9 males to 100 females. With 3% lactic acid 171 young showed a sex ratio of 61.3 males to 100 females, while among 163 young from the same females treated with 5% sodium bicarbonate the sex ratio was 207.5 males to 100 females. Combining all the young from females treated with lactic acid, we have 110 males and 159 females, which is a sex ratio of 69.2 males to 100 females. The same females with the combined 3% and 5% sodium bicarbonate treatments produced 165 males to 96 females, a sex ratio of 171.9 males to 100 females.

Table III gives the litters of the sires used with females treated with the lactic acid and sodium bicarbonate of various strengths. The litters from male 1378 show no significant differences in the sex ratio with the various treatments. Fifteen litters by this male mated to females treated with lactic acid contained 49 males and 61 females, while 8 litters from this male mated to females treated with sodium bicarbonate contained 37 males and 29 females.

The only sex ratios of untreated females which we have are those taken at weaning time. In one group of 176 litters there were 644 males and 640 females. In a second group of 74 there were 295 males and 269 females. In a third group of 128 litters there were 412 males and 362 females. All the animals with which we worked were related to these three groups. Taken all together, we have 378 litters with 1351 males and 1271 females, showing a sex ratio of 106.3 males to 100 females.

Table I. The sex ratio among offspring of females (rats) treated with lactic acid and sodium bicarbonate.

Treatment	Average pH	Litters	Males	Females	Sex-ratio Males	Sex-ratio Females	Litter size
2% L. A.	2.22	32	111	163	68.1	100	8.56
3% L. A.	2.10	69	166	301	55.1	100	6.77
3% S. B.	8.31	35	157	126	124.6	100	8.09
5% S. B.	8.07	70	366	177	206.8	100	7.76

Table II. The sex-ratio among offspring of the same females treated with lactic acid and sodium bicarbonate (rats).

Treatment	Number of females	Litters	Males	Females	Sex-ratio Males	Sex-ratio Females	Litter size
2% L. A.	10	11	45	53	84.9	100	8.91
3% S. B.	10	11	55	43	127.9	100	8.91
3% L. A.	21	26	65	106	61.3	100	6.58
5% S. B.	21	24	110	53	207.5	100	6.79

Summary

Douching females with lactic acid before mating was effective in increasing the proportion of females, while the use of sodium bicarbonate increased the proportion of males.

TABLE III. Progeny of Individual Males Mated to Females Following Various Treatments.

Number of male	2% Lactic acid			3% Lactic acid			3% Sodium bicarbonate			5% Sodium bicarbonate		
	Litters	Males	Females	Litters	Males	Females	Litters	Males	Females	Litter	Males	Females
1349	1	2	6									
1363	9	40	46	13	36	66	12	61	38	9	62	22
1376	1	3	6									
1377	2	6	7				4	20	17			
1378	7	24	29	8	25	32	3	12	13	5	25	16
1412	3	12	18				1	3	2			
1413	1	3	7									
1423				1	3	3						
1424							1	5	5			
1430							1	3	5			
1486				1	2	6	4	14	14	1	6	4
1487	8	21	44	29	60	134	8	36	29	29	151	70
1488				4	10	19				12	60	30
1490										1	4	3
1560				2	7	5				1	2	1
1563										1	6	4
1655				1	3	6				1	5	2
1662										1	7	3
1682				1	0	2				1	6	2
1683				3	4	3				1	6	2
1684				4	7	5				4	16	14
1685										2	5	3
1700				4	12	23				1	5	1
Totals	32	111	163	71	169	304	34	164	123	70	366	177

A TEST OF SEX CONTROL BY MODIFICATION OF THE ACID-ALKALINE BALANCE*

(Preliminary Report)

LEON J. COLE, EMANUEL WALETZKY AND MAX SHACKELFORD
University of Wisconsin

AT these meetings a year ago the senior author presented a brief informal review of recent attempts to control sex in certain mammals, including man, by means of chemical treatment of the vagina preceding copulation. These attempts extended from the early reports by Unterberger in 1930 on an excess of human male births following treatment with sodium bicarbonate to the experiments conducted at the Applied Research Laboratories, Inc., of Dayton, N. J., for the New York *News*, and publicized in its columns from time to time as the work progressed. These results have since been published in book form by Mr. Carl Warren under the title "Animal Sex Control."† The thesis of the book is that the relative ability of the male-determining and female-determining spermatozoa to fertilize the discharged ova in the female reproductive tract is affected by the acid-alkaline reaction of the tract, an alkaline balance resulting in more males, and an acid condition in more female offspring. The data presented were significantly favorable to such an interpretation.

Both the theoretical interest of such a result and its great practical importance to stock breeders, should it prove of general application to farm animals, made it seem highly desirable that attempts at confirmation should be undertaken. In order that the test might be made by methods duplicating as nearly as possible those employed at the Dayton Laboratory, we suggested cooperation in the effort. The *News* generously responded by making it possible for Mr. Thomas Durfee, at that time director of the Dayton Laboratory, to visit Wisconsin and to inspect and criticize our work and techniques shortly after the inception of our experiments. A few slight changes that he suggested were adopted. These included strengthening the solutions used for douching from 1% lactic acid and 3% sodium bicarbonate, which were previously recommended as the optimum, to 3% or 5% lactic acid and 5% $NaHCO_3$, respectively. In the work with rats, at the start the females were put with males immediately after the douching and left with them for two hours. But rough observations indicated that the influence of the douche on the vaginal *pH* is fairly transitory and is largely dissipated after one hour; accordingly the mating period was later reduced to a half hour, and the douche repeated if there were no signs of mating having occurred. Since none of the aforementioned variations in treatment produced any significant deviations all the data on the rats are summarized in the upper part of Table I. It will be noted that the highest male ratio occurred in the controls, next with the lactic acid, and lowest with the alkaline treatment, which is supposed to produce an excess of males. However, none of the ratios deviates significantly from equality.

Results with rabbits fully as startling as those with rats were reported by the Applied Research Laboratories. Our experiments with rabbits have been less extensive than those with rats, but we have again tried to duplicate as closely as possible the techniques used by the Dayton Laboratory. In this case, 2% lactic acid and 2% $NaHCO_3$ were recommended as optimum. Does in estrus were placed with bucks for 15 minutes after being douched. One or two matings usually occurred in this time. Like those with the rats, the rab-

*Paper No. 271 from the Department of Genetics, Wisconsin Agricultural Experiment Station. This investigation has been supported in part by a grant made by the Trustees of the Brittingham Fund. We wish also to thank Dr. Harry Steenbock for his interest and for furnishing us with rats; also the Department of Biochemistry for use of a room in that building.

†Orange Judd Publishing Company, Inc. 1940.

bit results were negative, as shown in the lower part of Table I. Again the higher male ratio occurred with the lactic acid but the difference is not significant (difference less than its standard error).

Insemination Experiments

In view of the large series of negative results with rats, it was considered unprofitable to continue the douching work with rabbits. It seemed questionable whether the *pH* of the semen was really altered in either the rat or the rabbit by vaginal douching. In the rat, particularly, the sperm pass into the uterus almost immediately after ejaculation. It was therefore decided to use a technique which would permit a direct alteration of the *pH* of the semen and at the same time admit a higher degree of standardization. Semen was accordingly secured from the bucks by the use of an artificial vagina manipulated under a dummy. The semen was examined immediately, and if its motility was satisfactory the *pH* was determined in a Beckman potentiometer.

The *pH* of the freshly collected semen ranged from 6.7 to 7.9, with a mean of 7.26. Some of this variability was due to the jellylike fraction of the semen. This was ordinarily separated and discarded, but occasionally this proved impossible. The *pH* was then altered as desired by adding different quantities of standardized solutions of lactic acid, KH_2PO_4, or $NaHCO_3$ to the semen. In all but one sample the maximum dilution used was one part of semen to two parts of diluting solution. The *pH* of the semen changed abruptly immediately after dilution and remained constant at its new level. The change in *pH* was accompanied by an equally abrupt diminution in motility, which lasted until the semen was injected into the female tract. Inseminations were made at three *pH* ranges, viz., 3.8-5.1 (lactic acid), 5.6-6.2 (KH_2PO_4) and 7.9 - 9.2 ($NaHCO_3$). No motility was present below a *pH* of 5.0 or above a *pH* of 8.8. Ordinarily, only a slight undulatory, non-progressive movement of a few spermatozoa was observable between the *pH* ranges of 5.6 to 6.2, and 7.9 to 8.8. The altered semen ordinarily stood at room temperature for 15 minutes, although a few samples were held for an hour, and were then used for insemination. In order to insure ovulation the does were bred to vasectomized bucks not more than two hours prior to insemination. Two does were generally inseminated from a single collection of semen.

The data so far available are presented in Table II. No fertility resulted from eight inseminations with lactic acid and in the other two series the results do not differ significantly from each other or from equality. It should be noted that the *pH* of the semen treated with $NaHCO_3$ is in the neighborhood of the 2% solution used by the Applied Research Laboratory in their douching experiments.

To summarize briefly: Our experiments on the effectiveness of acid or alkaline douches in rats and rabbits, and of the direct control of the *pH* of the semen of rabbits before insemination, have given entirely negative results, thus failing to confirm the partial control reported by some others. It is possible that sex ratios in mammals may at times be considerably modified, but there is still so much uncertainty as to what are the factors concerned and how they operate that the whole subject must be considered as still in the experimental stage. Certainly, there is at present no safe ground for a broad recommendation of any method of sex control in livestock breeding or in human biology.

Table I. Douching Experiments

Animal	Treatment	Litters	Total Young	♂♂	♀♀	♂♂/♀♀	Litter Size
Rat	Lactic Acid	142	855	447	408	52.3±1.7	6.1
	$NaHCO_3$	129	891	452	439	50.7±1.7	6.9
	Control	62	442	239	203	54.1±2.4	7.2
	Total	333	2188	1138	1050	52.0±1.1	6.6
Rabbit	2% Lactic Acid	15	116	59	57	50.9±4.6	7.7
	2% $NaHCO_3$	20	170	81	89	47.6±3.8	8.5
	Total	35	286	140	146	49.0±3.0	8.2

Table II. Artificial Insemination - Rabbits

Chemical	Semen pH at Insemination	Females	Litters	♂♂	♀♀	Total
Lactic Acid	3.8 - 5.1	8	0	0	0	0
KH_2PO_4	5.6 - 6.2	17	11	29	35	64
$NaHCO_3$	7.9 - 9.2	13	9	20	23	43
Total		39	20	49	58	107

AN EXPERIMENTAL ATTEMPT TO MODIFY THE SEX RATIO

In Rats and Rabbits*

J. H. QUISENBERRY AND S. V. CHANDIRAMANI†

SEX control has long been a strong desire of man. Because of the intensity of this desire and the far-reaching consequences of such control, interest in the subject has been keen. Many attempts have been made to control sex by one means or another. Since the discovery of the role of the genes and chromosomes in sex determination, the futility of many of the early attempts has become obvious.

Basically, sex in mammals is determined by the type of sperm fertilizing the egg, *X*-bearing sperms producing females and *Y*-bearing sperms producing males.

Recognition of this fact has led later workers to attempt the control of the type of sperm that fertilizes the egg. Attempts to separate the two kinds of sperms, for practical uses, on the basis of size, weight, and electrical charges have been unsuccessful.

Recently, claims have been made for physico-chemical methods of sperm differentiation. Warren,‡ in his recent book on *Animal Sex Control,* cites the work of Unterberger of Germany, the Taylors of England, and that of Durfee at the Applied Research Laboratories, Dayton, New Jersey. Claims of phenomenal success in modifying the sex ratio by the use of acid and alkali douches immediately preceding coitus have been made by Durfee and his newspaper sponsors, the New York *News.*

In September, 1939, the authors began an experiment designed to check the work done by Durfee at the Applied Research Laboratories. Accordingly, his procedure as to concentration of solution and technique was followed as closely as possible.

Materials and Methods

Two strains of rats were used in this experiment.§ Rat Strain No. 1 consisted of a hooded and defective-eyed group. The sex ratio, expressed as percentage of males in the sample, in the untreated controls of 1337 offspring was 52.10. Rat Strain No. 2 consisted of a highly inbred albino group in which the percentage of males in the untreated controls of 1001 offspring was 44.86. The rabbits used in these tests consisted of a small mixed group maintained in the Animal Breeding Laboratory of the Genetics Department, into which no outside blood had been introduced for the past four years. The percentage of males in the untreated controls of 224 young was 47.77.

The rat and one group of rabbit females were douched with a 3% sodium bicarbonate (U.S.P. Grade) and 2% lactic acid solution (U.S.P. Grade). One group of rabbit females was douched with a 5% sodium bicarbonate solution. Fresh solutions were prepared one to three times weekly. The rats were tested for estrum by the vaginal smear method and when found in heat were douched thoroughly. At least three medicine droppers of the solution were aspirated in the vagina. The female was then placed with the male and left for one hour to one hour and fifty minutes. Copulation was indicated by the presence of the vaginal plug or by sperm in a second vaginal

*The work on rats was done by Mr. S. V. Chandiramani under the supervision of J. H. Quisenberry in fulfillment of the thesis requirements for the M.S. Degree in Genetics at the Agricultural and Mechanical College of Texas.

†Associate Professor, and formerly graduate student in the Genetics Department of the Agriculture and Mechanical College of Texas, respectively.

‡WARREN, CARL. Animal Sex Control. Orange Judd Publishing Company, New York. 174 pp. 1940.

§These rats were obtained from the Swine Division of the Texas Agricultural Experiment Station for which we are deeply grateful.

smear. If no indication of mating was found, the females were douched and placed with the male again and so on until they mated or went out of estrum.

The rabbit females were douched with a specially prepared pipette. Fifty c.c. of solution were used for each female. After douching, the females were placed immediately in the pen with the males and copulation took place at once. In no case did mating occur more than ten minutes after douching.

Results

Rat Strain No. 1 produced a total of 269 young (136 ♂, 133 ♀) in 43 litters, with alkali treatment. The sex ratio in these young is 50.5 per cent male. With acid treatment, 185 young (88 ♂, 97 ♀) in 29 litters were obtained. They show a ratio of 47.57 per cent males.

Eighteen of these females produced a litter in each treatment. With sodium bicarbonate they gave 126 young having a ratio of 51.59 per cent males (65 ♂, 61 ♀). With acid they gave 111 young having a ratio of 50.45 per cent males (56 ♂, 55 ♀).

Rat Strain No. 2 gave 118 young in 13 litters, with a ratio of 50.85 per cent males (60 ♂, 58 ♀), in alkali treatment. With acid treatment, 172 young (88 ♂, 84 ♀) were obtained in 25 litters. The ratio was 51.16 per cent males.

Here only five females gave a litter in each treatment. With alkali treatment, 47 young were obtained with a ratio of 53.19 per cent males (25 ♂, 22 ♀). With acid treatment 35 young were obtained with a ratio of 51.43 per cent males (18 ♂, 17 ♀).

One group of rabbit females was douched with a 3% solution of sodium bicarbonate. The strength of the solution was later increased to 5% and another group of litters has been obtained

TABLE I. Summary for both Treatments in all Three Stocks.

Stock	Control		Treated Offspring						
	*Sex-Ratio	Mean Litter Size	Treatment	Total Young	No. of Litters	Males	Females	*Sex Ratio	Mean Litter Size
Rat Strain No. 1	52.10 (1336 Yg - 128 L) (696 M, 640 F)	7.11	Alkali	269	43	136	133	50.56 ± 8.20	6.26
			Acid	185	29	88	97	47.57 ± 6.79	6.38
Rat Strain No. 2	44.86 (1001 Yg - 116 L) (449 M, 552 F)	8.63	Alkali	118	13	60	58	50.85 ± 5.43	9.08
			Acid	172	25	88	84	51.16 ± 6.56	6.88
Rabbits	47.77 (224 Yg - 53 L) (107 M, 117 F)	4.23	Alkali 3%	47	8	21	26	44.68 ± 3.41	5.38
			5%	49	8	32	17	65.31 ± 3.33	6.13
			Acid	88	16	32	56	36.36 ± 4.51	5.50

*Expressed as percentage of males in the population births.

TABLE II. Summary of Females Giving Litters with both Acid and Bicarbonate Douches.

Stock	No. of Females	Lactic Acid Douche			Bicarbonate Douche		
		Males	Females	Sex-ratio	Males	Females	Sex-ratio
Rat Strain No. 1	18	56	55	50.45 ± 5.27	65	61	51.59 ± 5.61
Rat Strain No. 2	5	18	17	51.43 ± 2.96	25	22	53.19 ± 3.42
Rabbits	10	26	50	34.21 ± 4.14	42	36	53.35 ± 4.40

from females douched with the stronger solution. With a 3% bicarbonate solution the rabbits gave 47 young with a sex ratio of 44.68 (21 ♂, 26 ♀). With a 5% solution, 48 young have been obtained with a sex ratio of 65.31 (32 ♂, 17 ♀). With the acid douche, 88 offspring have been obtained with a sex ratio of 36.36 (32 ♂, 56 ♀).

Ten of the rabbit females gave litters with each of the kinds of douches. With the bicarbonate douche, 78 offspring with a sex ratio of 53.85 were obtained (42 ♂, 36 ♀). With the acid douche, 76 offspring obtained gave a sex ratio of 34.21 (26 ♂, 50 ♀).

Discussion and Conclusions

The results are summarized in Tables I and II. The sex ratios of the offspring obtained in each strain and treatment have been tested for goodness of fit by the use of Chi-square. In no instance for the rats is the deviation from the strain controls significant. We have failed to confirm the reversals claimed by Durfee at the Applied Research Laboratory. The concentration of solution used by Durfee followed the suggestion of the Taylor doctors in that he adopted a *pH* range of 4 to 5.5 for acid treatment, and 8 to 10 for alkali treatment. The 3% sodium bicarbonate solution used by us had a *pH* of 8.28, and the 2% lactic acid had a *pH* of 2.19. The alkali treatment is within the suggested limits. The acid had a much lower *pH* but gave no confirmation of the work done by Durfee at the Applied Research Laboratory.

Our results show that under the conditions of our tests as described above no significant departure from the untreated control sex ratios was obtained for rats. The rabbit offspring obtained from the two types of douches, when tested by a two-by-two table, gave a Chi-square of 7.10. With one degree of freedom, a Chi-square value of 6.635 is necessary for a *P* value of .01. The calculated Chi-square for the sex ratios obtained is larger than this value, indicating that these two groups could not belong to the same population. The number of offspring obtained is still small and we are continuing the douching program on rabbits. However, the number of rats obtained is sufficiently large to give us assurance that no significant departure may be expected in rats under the conditions of our tests.

REPORT OF THE COMMITTEE ON MOUSE GENETICS NOMENCLATURE

In the September, 1939, issue of this JOURNAL is reported the establishment of a Committee on Mouse Genetics Nomenclature, consisting of F. A. E. Crew, L. C. Dunn and G. D. Snell. Owing to war duties, Prof. Crew has been unable to participate in the work of the committee, and his place has been taken by Dr. Hans Grüneberg. The initial program of the committee is now completed and is reported herewith.

The American members of the committee were unable to meet with Prof. Crew or Dr. Grüneberg in Edinburgh as originally planned, but they have kept in constant touch with Dr. Grüneberg by mail. Following the discussion at the Seventh International Genetics Congress, described in the above mentioned report in the JOURNAL OF HEREDITY, the committee corresponded with a number of geneticists in order to get suggestions and advice. After careful consideration of the suggestions received, it appeared that opinion was divided between two possible systems of symbols for mutations in mice. Consequently a circular letter describing these systems, together with a ballot, was sent to interested biologists. Of 43 ballots returned 23 favored system I, 16 favored system II and four expressed no choice. System I is essentially the system at present used by most rodent geneticists, and this system has been adopted by the committee. The recommendations of the committee are given below.

Rules for Assigning Symbols to Mutations

1. *The initial letter* of the mutant symbol shall be the same as the initial letter of the mutant gene, e.g., *d* for dilution.

2. *Additional letters* shall be added to the initial letter if necessary to distinguish it from symbols already in use. These shall be, preferably, those immediately following the initial letter, or suggestive letters, especially consonants, from the rest of the name, e.g., *dw* for dwarf, *ac* for absence of corpus callosum.

3. *Recessive mutations* shall be indicated by the use of a small initial letter for the symbol of the mutant gene, the type allele being distinguished by a capital letter, *e.g., a* for non-agouti, *A* for agouti.

4. *Dominant mutations* shall be indicated by the use of a capital initial letter for the symbol of the mutant gene, the type allele being distinguished by a small initial letter, e.g., *Re* for rex, *re* for the type allele of rex.

5. *The wild type* may also be represented by a + rather than by a letter when this is more convenient, or by a small letter with a + superscript, e.g., + or t^+ for the type allele of *T*, + or a^+ for the type allele of *a*.

6. *Multiple alleles* (except lethals) shall be indicated by the use of superscripts (always small letters, never capitals) added to the symbol of the original mutant type, e.g., c^{ch} for chinchilla. It is suggested that the letter selected be the initial letter of the name of the mutation, e.g., T^t for the fused allele of brachyury. The initial letter of the name of the discoverer may also be used. Lethal alleles in a multiple series may be indicated by the use of superscript numerals, e.g., t^0 and t^1 for the lethal alleles of brachyury.

7. *Mimics*, i.e., mutants of similar phenotype but different location, shall be indicated either by entirely different names and symbols (e.g., *ln* for leaden and *d* for dilution) or by the same name and symbol with the addition of distinguishing numbers (e.g., *wa-1* for waved-1 and *wa-2* for waved-2). The latter procedure is not recommended.

8. *In published articles* in American journals in which symbols are used, the symbols should be set in italics.

List of Mutant Genes and Recommended Symbols

Mutation	Recommended symbol	Linkage group (if any)
Agouti series (agouti, non-agouti, black-and-tan, light-bellied-agouti, lethal yellow)	+ *a* a^t A^w A^y	V
absense of corpus callosum	*ac*	
brown	*b*	
albino series (color, intense chinchilla, chinchilla, extreme dilution, albinism)	+ c^i c^{ch} c^e *c*	I
caracul	*Ca*	VI
dilution	*d*	II
dwarf	*dw*	
flexed tail	*f*	
grey-lethal	*gl*	
hairless	*hr*	III
hydrocephalus-1	*hy-1*	
hydrocephalus-2	*hy-2*	
leaden	*ln*	
myelencephalic blebs	*my*	
naked	*N*	VI
pink-eye	*p*	I
pallid (pink-eye-2)	*pa*	V
rodless retina	*r*	IV
rex	*Re*	
piebald	*s*	III
short-Danforth	*Sd*	
short-ear	*se*	II
shaker-1	*sh-1*	I
shaker-2	*sh-2*	VII
silver	*si*	IV
shaker short	*st*	
brachyury series (type, brachyury, fused tail, lethal allele, lethal allele)	+ *T* T^t t^0 t^1	
waltzing	*v*	
dominant spotting series (type, dominant spotting, viable dominant spotting)	+ *W* W^v	
waved-1	*wa-1*	
waved-2	*wa-2*	VII

In conclusion the committee would like to thank the various geneticists who have cooperated by replying, often in considerable detail, to questions sent them by the committee. These replies have been most useful in drawing up a workable set of rules and symbols.

L. C. Dunn,
H. Grüneberg,
G. D. Snell.

NATURAL "EAR-RING" HOLES

Inherited Sinuses of the Ear Lobe

HENRY W. EDMONDS AND CLYDE E. KEELER*

ANATOMICAL variations of the human ear are especially liable to observation, thanks to the exposed position of this organ, and to the various manipulations to which it is subjected. Recently one of us (C. E. K.) had occasion to draw blood from the ear of a woman, for use in blood-grouping. Attention was attracted to what at first glance appeared to be old puncture marks for ear-rings. Small pits were present on both inner and outer surfaces of the lobe of the left ear. When asked about these markings, the subject denied that her ears had ever been pierced artificially. She stated that the pits had been present since birth, and that her child had been born with similar pits. Subsequent follow-up of the family of this woman has supplied the first pedigree to be presented below.

Shortly after the study of this first family had been concluded, one of us (H. W. E.) noticed the identical anomaly in an infant, the subject of postmortem examination at the Boston Lying-In Hospital. Investigation of the family of this infant resulted in the second pedigree here to be presented.

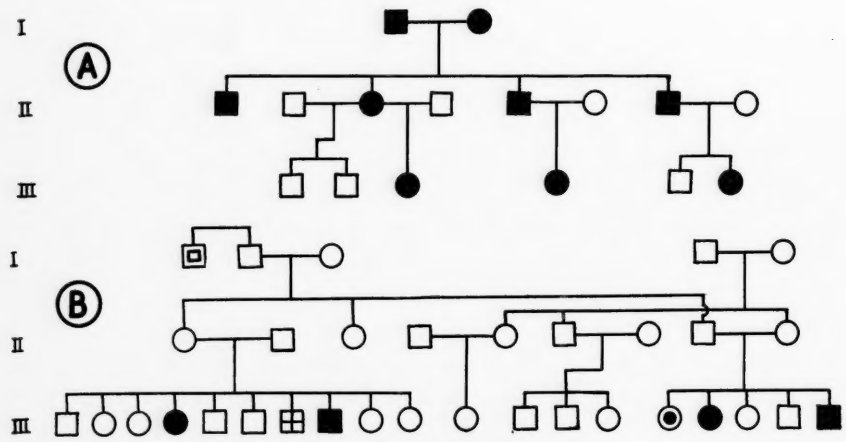
The character under consideration is variable in its expression. In its typical form it consists of a round or lenticular pit about a millimeter deep, situated in the middle of the lateral surface of the lobe of the ear, associated with a similar pit at a corresponding position on the medial surface of the lobe. These pits are of a size sufficient to admit the tip of a sharpened lead-pencil, and (at least in our series) do not communicate with one another. The appearance of these natural pits in the adult ear may be indistinguishable from that of old healed ear-ring puncture marks. The skin lining these small sinuses is most probably equipped with sebaceous glands, since small plugs of inspissated secretion are frequently encountered in the pits.

When the pits are lenticular or slightly elongated, it is usual for the long axis to be directed obliquely, with the upper end in front of the lower end. In some individuals, in whom the trait is less strongly expressed, pits may be developed in one ear only. In others, a pit may appear on the medial surface of a lobe and not on the lateral surface. The reverse situation, a lateral pit without a corresponding pit on the medial surface, has been noted only once (individual III-8, in the *Kr.* family). It is of interest that the character has shown more pleomorphism in this family than in our other group.

There are several situations on and about the ear in which sinuses (small fistulae) are known to occur. The commonest of these sites is immediately in front of the ascending limb of the helix, that is, directly in front of the upper anterior border of the external ear, on the cheek. This is the type recently studied by Kindred,[7] by Whitney[14] and by Quelprud.[12] Considerably less frequent than such pre-auricular sinuses are fistulae in the mid portion of the descending limb of the helix, that is, in the rolled posterior border of the external ear. The earliest case described[2] was of this type. Lastly, there are sinuses of the type found in the families here reported; sinuses of the lobe, or most dependent portion of the external ear. Good descriptions of this last type have been published by Bland-Sutton,[3] and by Lannelongue and Menard.[8]

The association of fistulae with other more serious congenital malformations of the ear, such as microtia, has been

*Former Research Fellow, Department of Obstetrics of Harvard University, and Research Fellow in Genetics, Wistar Institute of Anatomy and Biology, respectively.



PEDIGREES OF "PIERCED" EARS

Figure 1

Pedigree *A* is of the *Bo* family; *B* of the *Kr* family. The families are in no way related. The special symbols are explained in the text on this page.

noted by Bland-Sutton,[3] also by Marx.[10]

The similarity between congenital sinuses of the lobe and acquired sinuses of this part of the ear (artificial perforation for rings) is striking. The question of inheritance of an acquired character was first raised and refuted by Bland-Sutton.[3] Too, Ballantyne[1] notes that "the birth in very ancient times of an infant with this malformation may have suggested to a tribe, or to mankind generally, the practice of ear-boring. The traumatism may not have caused the congenital malformation, but, in a sense, the occasional occurrence of the malformation may have led to the frequent infliction of the traumatism!"

To our knowledge, the inheritance of sinuses of the lobe has not previously been recorded in medical literature, although the familial incidence of sinuses in the more common sites was noted as early as 1864 by Heusinger.[5] The literature is reviewed by Marx.[10] Incomplete dominance is the usual mode of inheritance.

Report of Cases

1. *The Bo. family.* Individual II-3, (Figure 1*A*) was the case that led to our interest in this family. Her pits, while well developed, are present on the left ear only. The three brothers of this woman, as well as her mother, all have pits on the left ear only, with no abnormality of the right ear.

The woman's father (I-1) shows complete bilateral development of the pits. The occurrence of such an unusual trait in both husband and wife (I-1 and I-2) is interesting. While the subjects deny consanguinity, they state that they both came from the same small village in Italy.

The children III-3, III-4, and III-6 show pitting of both ears; however, III-4 and III-6 show pitting of the medial ear surfaces only.

The remaining members of this family have normal ears.

2. *The Kr. family* (Figure 1*B*) is in no way related to the people just discussed, being of Russian descent. Our attention was first drawn to the infant III-19. This child died four days after birth, because of intracranial hemorrhage. Both ears displayed typical pits in the lateral and medial surfaces of the lobes. Complete post mortem examination dis-

EARS "PUNCTURED" BY NATURE
Figure 2

The punctures are located at exactly the place where an artificial ear puncture would appear. They are a fake to the extent that they do not extend all the way through the lobe. Such naurally "pierced" ear lobes have erroneously been cited more than once as evidence of the inheritance of an acquired characteristic.

closed no other congenital anomalies.

The oldest sister (III-15) shows marked reduction of the external ear, corresponding to microtia of medium grade severity as described by Marx.[9,10] The pinna or external ear is a small flattened fleshy appendage, in which a rudimentary plate of cartilage can be palpated. The meatus, or external canal of the ear, is atretic, consisting of a shallow dimple. The underlying portions of the temporal bone seem normal on palpation. There is some impairment of hearing. A small pit on the medial surface of the abnormal pinna is situated five millimeters above the level of the meatus, on what is probably the rudiment of the lobe. Allowing for the obvious deformity of the ear, this pit corresponds quite well to our typical sinus of the medial surface of the lobe. The left ear of this child is normal.

A second sister, III-16, has a small pit on the medial surface of the lobe of an otherwise normal left ear. The right ear is normal.

A third sister, a brother, the mother and the father all have no trace of any pits. The relatives of the mother, at least as far as could be followed, have only normal ears.

Individual III-4, a cousin of our original case, has a typical pit on the medial surface of her left ear. Her brother, III-8, has a characteristic pit in the *lateral* surface of each ear, without corresponding sinuses on the medial surfaces. Another brother, III-7, has a small prehelicine sinus in front of the right ear, without other peculiarities.

The grandmother, I-3, who herself has normal ears, stated that her brother-in-law (I-1) had a deformity of his ear similar to that observed in her granddaughter (III-15).

Discussion

Our present data are not conclusive as to mode of inheritance of pits of the ear lobe. They are perhaps best interpreted on a theory of irregular dominance. There is no significant difference in sex incidence.

Some interesting points are raised by the observations on these families. First, is there any causal relation between sinuses of the lobe and the prehelicine sinus, or between sinuses of the lobe and microtia? Are the same developmental factors responsible for these various anomalies? One can only speculate on this question, as no evidence is at hand. The association of these malformations in the sibships of the *Kr.* family is no more than suggestive of such relation.

Second, the suppression of the characteristic development of lobe sinuses, so

that pits appear on only one surface of an ear, implies the action of modifying factors. Are these factors genetic? Here again, little evidence can be offered. We have noted that pits are usually prominent in larger, free-hanging lobes, while they are smaller in lobes that are adherent to the cheek. Adherent lobes have been reported[11] as an inherited character, being recessive to free hanging lobes.

Third, of the eleven affected individuals observed in our two families, pits appeared bilaterally in six cases, on the left side only, in seven, and on the right side only, in one case. What is the reason for this relative immunity of the right side, as opposed to the left? Similar differences in laterality are well known in such malformations as harelip and diaphragmatic hernia. It is possible that the greater incidence of these known developmental arrests on the left side of the body may be referred to lower metabolic gradients on this side. Whether or not pitting of the ear lobule is such a malformation of growth arrest (incomplete closure of a normal embryonic sinus) is certainly an open question.

The embryology of sinuses on and about the ear is uncertain. Betz[2] considered such sinuses to be abortive accessory auditory canals, derived from the first branchial cleft. The classical description by His[6] of the tubercles projecting from the primordium of the developing ear was applied by Bland-Sutton[3] in referring fistulae of the lobe to the persistence of a gap between the tubercles numbered 1, 5, and 6 by His. Whitney[14] considers the prehelicine sinus a result of lack of fusion of tubercles 2 and 3. On the other hand, Streeter's[13] important study of the ear in human embryos concludes that the tubercles described by His "are of a transitory character and are incidental, rather than fundamental, to the development of the auricle," disappearing soon after their formation. Streeter points out that the tubercles appear in embryos of reptiles and birds, though in these no pinna ever develops. It seems unlikely that sinuses of the ear can be explained by the persistence of spaces between these rudimentary tubercles, for as shown in Streeter's reconstructions, the tubercles are only low swellings, never separated with any degree of distinctness.

Conclusion

We have presented pedigrees of two unrelated families in which sinuses of the lobe of the ear are inherited, apparently as an irregularly dominant character. Literature relevant to the genetics and embryology of sinuses on and about the ear has been reviewed.

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GENETICS, CHEMISTRY, AND CANCER*

FREDERICK S. HAMMETT
The Lankenau Hospital Research Institute, Philadelphia, Penna.

THIS statement is an attempt to provide a reasoned basis for integration of genetics and chemistry in the study of cancer as a growth, based on a series of experiments at the Lankenau Hospital Research Institute.

The present constellation of chemical elements is the product of *inorganic evolution*. Though transformations may occur, these either are produced by highly artificial means or the rate of natural occurrence is so slow that we may neglect them in the present exposition.

The present constellation of genetic elements is the product of *organic evolution*. Here also change can apparently be induced by artificial means, and natural saltations may occur. These events, however, are too rare to be pertinent to the present discussion.

It can therefore be freely held that this occasional mutability of the chemical and genetic elements does not detract from the belief that a high degree of fixation has been arrived at insofar as our particular time range of observation is concerned.

Therefore the chemical law of conservation and the genetic law that like begets like are something more than approximations; they are expressions of true succession and continuance.

The essence of the law of chemical conservation is that regardless of multiplicity or kind of chemical combinations entered into or departed from by any chemical element, the identity, integrity, and transmissibility of the element as an entity remains unchanged.

The essence of the law that like begets like is that regardless of the multiplicity or kind of genetic combinations entered into or departed from by any genetic element, the identity, integrity, and transmissibility of the element as an entity remains unchanged.

This common characteristic of persistence in both the chemical and the genetic elements suggests a relation between the two.

It is clear there could be no inheritance in living things if the constituent chemical elements and the properties inherited therein did not persist as such. Quite obviously inheritance in living things depends upon this property of chemical persistence. Perhaps it even takes origin therefrom.

This is not as impossible as it might seem if realization and acceptance is had of the postulate that when the chemical elements go from the non-living to the living state they seem to express other potentialities and properties than those they exhibit in non-living substance.[2,4]

If one is convinced there is order in nature the law that like begets like may be conceived as an expression in living things of the law of conservation of chemical integrity.

The Law of Continuance

Perhaps a single law applies to both the living and the non-living. If so it might be called the Law of Continuance. And it might be stated thus: The elements of all substance and their inherent properties and functions tend to persist and hold on in uninterrupted succession throughout their transmigrations.

The chemical elements are thus the building tools of heredity, and heredity can be considered the dominating force for continuance in the inorganic world as it is in that of living organisms.

The peculiar properties of the particular elements suitable for the substance, reaction basis, and form of living not only make possible the exercise of the potentialities of heredity in organisms, they also set the limits thereto.

Heredity picks the specific chemical

*Read at the International Cancer Congress, Atlantic City, N. J., September, 1939. The research here reported was sustained by a Grant from The International Cancer Research Foundation.

groups which make an amoeba distinct from a yeast cell, and ensures that this characterizing chemical distinction shall persist.

Heredity sheathes some living things with chitin and others with keratin; it supports some on cellulose and others on calcium phosphate, and it ensures that substitutions do not occur too often.

The ability possessed by all developing and developed cells to pick from the environment and build into themselves just those particular chemical groups which by their association act to characterize the cell type as distinct from all others is an endowment from heredity.

The ordered production of a species-true organism is the property of heredity. Thus the species specificity in chemical composition, and the superimposed specificity in organ and tissue composition are determined through heredity. Heredity also sets the species, organ, tissue, and cellular specific course of development. Heredity thus selects the characterizing chemical building materials of the developing organism.

Cancer and the Law of Continuance

Cancer is an increasing mass of self-reproducing cells for which the Law of Continuance is a determinant. That is to say, the course of development and the distinctive chemical nature of cancer and cancer cells is set by heredity. I am here dealing with the heredity of cancer cells; not with that of the host.

The fact that cancer cells proliferate true to type, and form other cancer cells through many generations is sufficient evidence for the foregoing dictum.

Now the point of view may be taken that cancer is a sign of derangement in cellular developmental activity; a derangement from that which is considered normal for the site and state of the host. The cells multiply without apparent warrant and fail to reach a developmentally quiescent maturity. It follows that cancer is evidence the heredity-determined chemical processes concerned in this particular developmental activity are similarly abnormal; certainly abnormal for the status and the locus; perhaps abnormal in and of themselves.

The malignant character of cancer therefore seems in some part to reside in this derangement of the orderly course of developmental growth. If this assumption be admitted it follows that investigation into the chemical mechanisms, the chemical participants, and the chemical determinants used by heredity in the production of non-malignant species, organ, tissue, and cellular specific structures is a *sine qua non* for eventual understanding of that malignant growth which is cancer.

The Tissue Bricks

Thanks to the vision and understanding of Doctor Stanley P. Reimann, work along these lines has been in progress for now these past twelve years at The Lankenau Hospital Research Institute.

The work is based on the idea that each of the naturally occurring tissue components of general distribution has its own specific role to play in one or more of the developmental growth expressions common to living things wherever found.

These studies have been productive of much fundamental knowledge. Through them it has been possible to single out naturally occurring groups specifically concerned in each of the major developmental activities.

Thus it is possible to state that arginine carries a chemical configuration which is a factor in those preparatory processes essential to new growth initiation.[2] Other compounds such as guanine which carry a like grouping act similarly and sustain the postulate.[9]

By now everybody knows that the sulfhydryl group is an essential and specific participant in some phase of proliferation or cell increase in number.[1]

That the pyrrolidone group or some part or derivative thereof is a significant determinant of differentiation was shown by the early studies with glutamic and aspartic acids,[3,8] and confirmed and established by the latter with proline and hydroxyproline.[7]

In view of the recent report and emphasis of Kőgl that the glutamic acid of tumor tissue is not the naturally occurring compound but an optical isomer, it

is pertinent to state that in 1936 I pointed out in this very city the probable significance of glutamic acid to neoplasia.[6]

I said that cytological studies indicate the cancer cell does not differentiate to a normal degree. It does not mature as do other cells. Therefore since glutamic acid is specifically concerned in differentiation it is not improbable that the immaturity of the cancer cell may be associated with glutamic acid deficiency.

The report of Kőgl is pleasing support for this prediction.

Since later work, however, demonstrates pretty conclusively that it is the derived pyrrolidone group rather than glutamic acid itself which is concerned, it will probably be found that the optically unnatural compound of tumor tissue is incapable of releasing this effective configuration to the same extent as the natural. At least in tumor tissue.

It is not discouraging to realize that the cytological, chemical, growth, and analytical studies are consistently pointing in the same direction.

Returning to the growth studies it has been found that the final or structural organization stage of development to the functionable organism is definitely and specifically factored by guanine and adenine, with the probability that the effective grouping is imidine or some derivative thereof.

This brief statement of principles and illustrative examples from experimental results is presented — not as a record of work done — but as a suggestion for a line of approach to understanding of cancer as a growth.

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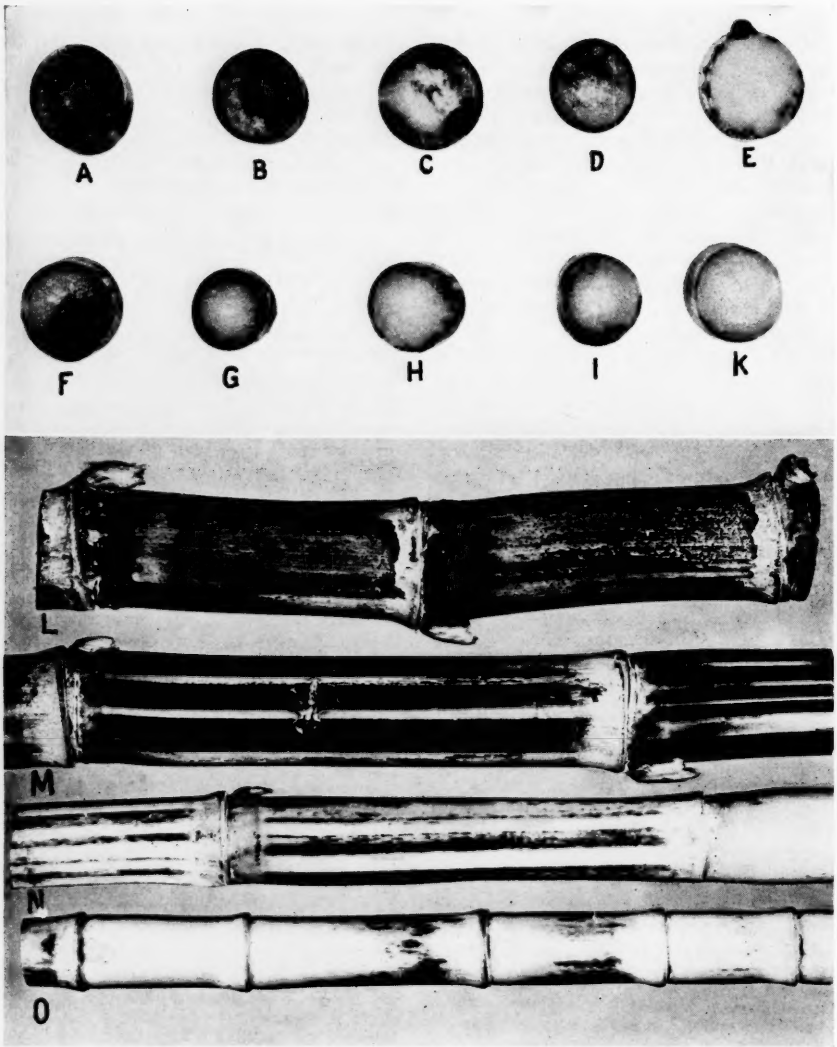
Distribution of the Blood Groups

If we assume that the main purpose of physical anthropology is to "unravel the course of human evolution," then the most valuable criteria of classification will be those which are objective, not subject to modification by the environment, determined genetically, by one or a small number of genes, non-adaptive, not subject to mutation at too high a rate. Of the characters considered here (blood groups, taste reactions to phenyl-thio-carbamide, stature, metrical characteristics of the skull, metrical characteristics of the rest of the body, pigmentation of skin, hair, and eyes, and physical characteristics of the hair) it seems that only in the case of blood groups is enough known to enable us to assume that this characteristic probably meets these five conditions. Some of the characters certainly do not. Blood grouping has been neglected by anthropologists because it became known relatively late, its intelligent use requires a knowledge of genetics, it points to conclusions not confirming older ideas of race. Of the possible evolutionary mechanisms capable of producing geographical variation in the frequency of a gene (mixture of a race possessing the gene with one without it, mixture of two races with different frequencies of the gene, mutation, selection, isolation, inbreeding) it seems likely that the distribution of the blood groups is largely due to the action of, first, isolation, then mixture. This seems in most cases to have preceded differentiation in regard to currently accepted anthropological criteria.—WILLIAM C. BOYD, *Amer. Jour. Phys. Anthrop.* Dec., 1940.



SECTIONS OF STALK OF STRIPED UBA

Figure 3

Transverse sections through the node and internodes (*A-K*) showing appearance of the stripes in a stalk. In the base of the stalk (*A-B*) many of the cells are dead, resulting in a dark coloration. Only the stripes are dead (dark tissue) in the upper part of the stalk. *L-O* shows sections of the same stalk from base to top showing the external appearance of the stripes.

NECROTIC STRIPES IN SUGARCANE

G. B. Sartoris

Senior Pathologist, Division of Sugar Plant Investigations, Bureau of Plant Industry, United States Department of Agriculture.

THE Striped Uba clone (*Saccharum sinense*) was found at Mount Edgecombe, Natal, Union of South Africa, by H. H. Dodds, growing among normal green Uba cane. In a letter concerning this clone Mr. Dodds wrote "There is also a striped variant of Uba to which we have never paid much attention, mainly because it is not a permanent character and is seldom reproduced on replanting." This clone (Figure 3), whose stalks have dark-brown stripes on a green background, was first believed to be a striped variant of Uba analogous to the striped mutants of self-colored cane found in many clones of sugarcane, more especially among the clones of *S. officinarum*. It was soon observed, however, that the brown stripes in this cane were not due to pigment but to layers of dead cells.

Striped Uba was imported by the Division of Sugar Plant Investigations, Bureau of Plant Industry, United States Department of Agriculture, in September, 1935. In the letter of transmittal Mr. Dodds wrote, "The striping does not usually show in the Uba variant until late in growth, if at all; we have therefore sent you cuttings from a stool of characteristic striped Uba cane, but these shoots have not yet developed the stripes, being at a suitable stage for planting. We have also enclosed for reference a cutting of the older material from the same stool that has developed characteristic stripes."

Plants from the cuttings imported from South Africa have been grown in the quarantine greenhouse at Arlington Farm, Va., since September 1935. All of the stalks have been striped, with the exception of one normal green stalk formed in a stool in 1938.

Cuttings from plants grown in quarantine were sent to the U. S. Sugar Plant Field Station, Canal Point, Fla., in 1937. The plants from these cuttings had striped stalks and a few normal green stalks. In March, 1938, when the cane was harvested there were several normal green stalks in each stool. In the following year the stubble of these same plants formed all normal green stalks. The striped characteristic was not as permanent in cane in the field at Canal Point as it was in cane in the greenhouse at Arlington Farm.

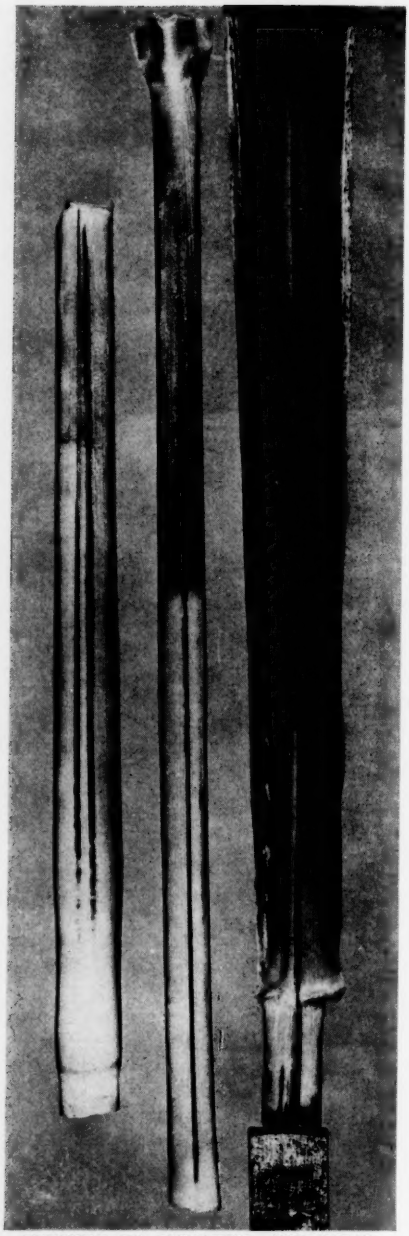
The normal green cane found in the greenhouse in 1938 was divided into single-eye cuttings. All of these cuttings produced normal green plants. Cuttings of striped stalks from the same stool produced striped plants and a few normal green plants.

The Development of Stripes

Most of the young plants of Striped Uba have narrow, dark-red stripes in the sheaths and blades (Figure 4). Sometimes a stripe in a sheath continues out into the blade, but, more often, the region at the juncture of the sheath and the blade is not traversed by the stripes (Figure 4). In most cases the stripes in the sheaths end about 2.5 centimeters from the base of the leaf blades and those in the blades begin about the same distance above the base of the blades. The stripes are about two to six millimeters wide and there may be one or two stripes in each leaf. The stripes in the midrib run the full length of the leaf blade while those formed nearer the edge of the leaf run out at the margin of the leaf at varying distances from the base. The stripes follow the parallel veins of the leaf. When the plants have formed stalks with three or four mature nodes the stripes in the leaves occur infrequently.

The Development of Stripes in the Leaf

The lethal mutation which gave rise to these strips of dead cells, most probably



STRIPES IN SHEATHS AND LEAF BLADE OF STRIPED UBA
Figure 4

The stripe disappears in the region where sheath and blade join.

arose in cells of the meristem of the growing point of a stalk of cane; however, growth is normal throughout the period of differentiation of the organs of the plant. It is only after the organs are formed that the affected cells degenerate. The beginning of this degeneration or formation of the streak in leaf sheaths can first be observed in the scales of the lateral buds. These scales are immature leaves, mostly sheath, the blade developing after germination. In a longitudinal section of a lateral bud from a striped cane (Figure 5*A*) are isolated groups of dead cells with blackened cell walls. As the sheath elongates the intervening cells die, thus forming a continuous streak of dead tissue. The width of the stripes in mature sheaths is usually somewhat broader than in the blades. The stripes are more clearly defined at the middle region and usually fade out at the top and base of the sheath. The initial cells of a stripe occupy the middle region, and development of the stripe is continuous with the elongation of the sheath. Therefore, the extremities of the stripes are made up of cells in the early stages of degeneration. A section through such a region (Figure 5*B*) shows the intercellular spaces filled with gum, and the walls of the cells surrounding the air cavity have turned black. A section through the middle region of a sheath (Figure 5*C*) shows that the stripe extends through the thickness of the sheath and that all the cells within the stripe are dead.

The development of a stripe in the leaf blade follows the same course as in the sheath. An early stage in the development of a stripe in the blade is shown in Figure 5*D*. This is a cross section near the extremity of a stripe in the midrib. The tissue between the small bundles near the lower surface of the blade is dead, the cell walls are black, and the intercellular spaces and some of the cells are filled with a dark-brown material. The parenchymal cells of the midrib are beginning to degenerate, the first indication is the filling of the intercellular spaces with gum (arrow Figure 5*D*). When a stripe is formed in

the midrib, several layers of cells are affected but the stripe does not extend through the entire breadth of the midrib. In the flat lateral portions of blades fully developed stripes are made up of a column of dead tissue that includes all the cells between the lower and upper epidermis and is as wide as the stripe. The parenchymal cells of the outer sheath of the bundles are the first to degenerate, and these are followed in order by the outer sheaths of the large bundles (Figure 6*A*), the mesophyll, and, finally, the fibrovascular tissue. A cross section of a mature stripe (Figure 5*E*) shows the dead tissue of a stripe at the left and at the right the normal tissue of the blade.

The Development of Stripes in the Stalk

The dark stripes on the stalk vary in width from a few millimeters to stripes that almost encircle the stalk. The stripes on mature internodes are dark brown and sharply defined, on less mature internodes the stripes are made up of stipples or numerous minute stripes. On the very young internodes there are only irregular blotches, (Figure 3 *L-O*).

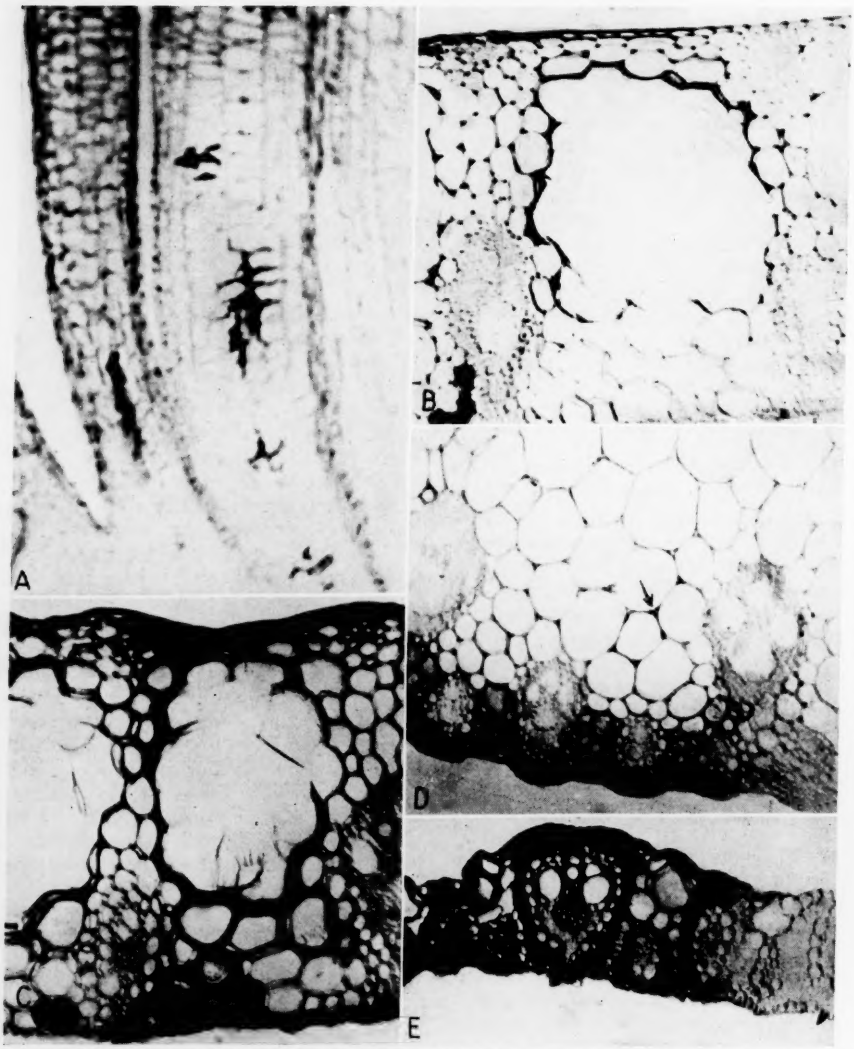
The beginning of a stripe in an immature internode is shown in Figure 6*B*. The first cells to degenerate are those in the cortical layer about three or four cells below the epidermis. Here a layer one to three cells wide is shown partially disintegrated. The intercellular spaces are filled with gum and the cell walls are blackened. The parenchymal cells between the bundles are affected. The tissue beneath green stripes is not affected. Figure 6*D*, shows a portion of a stripe at the right and normal tissue at the left. This is at a more advanced stage in the development. The phloem and xylem parenchyma of the fibrovascular bundles are alive and functioning. Even in a much later stage (Figure 6*C*) when most of the parenchyma is dead the bundles are not impaired. This is evident because the stalk continues to grow, which it could not do if the conducting tissue of the bundles were injured. It appears that only the parenchymal tissue is affected. Whether this is the result of the mutation or the diffusion of decomposition products from the dead cells of the cortical region cannot be determined. The sclerenchymal sheath of the bundles is not affected and is an effective barrier, also the one or two layers of lignified cells beneath the epidermis resist degeneration.

The course of stripes through a node is shown in Figure 3*E*. In this region there is very little parenchymal tissue, and the stripes are confined to narrow strips near the periphery of the stalk. In Figure 3*D* and *F*, are shown sections through the internodes below and above *E*, respectively. There is much blackened tissue in these internodes, as is to be expected, because there is much more parenchymal tissue.

The stages of degeneration in the same stalk are shown in Figure 3*A* to *K*. In the older internodes from the base of the stalk most of the parenchymal cells are black and the only living tissue is in the bundles, the hypodermal layer, and a thin layer of cells immediately below the green stripes. In the younger internodes the dead tissue is confined to a narrow region near the periphery. In the youngest internodes, in which definite stripes are visible to the eye, the dark tissue is a stripe a few cells thick in the cortical region. The cortex, according to Artschwager,[1] consists of the first few layers of cells under the epidermis. The two to four layers next to the epidermis consist of small, thick-walled lignified cells forming a sort of sclerenchymatous mantle. This zone is followed by a layer of thin-walled cells containing chloroplasts. The walls of these cells usually remain cellulose even in the mature portion of the stalk. The degeneration starts in the thin-walled chloroplast-bearing layer. In young internodes most of the stalk tissue is sound.

The epidermis and the first two or three layers beneath the epidermis are not affected until the stalk is very old. In the very old internodes some of the dead cortical cells collapse, thus form-

[1]Artschwager, Ernst. Anatomy of the Vegetative Organs of Sugar Cane. *Jour. Agr. Research* 30: 197-221, illus. 1925.



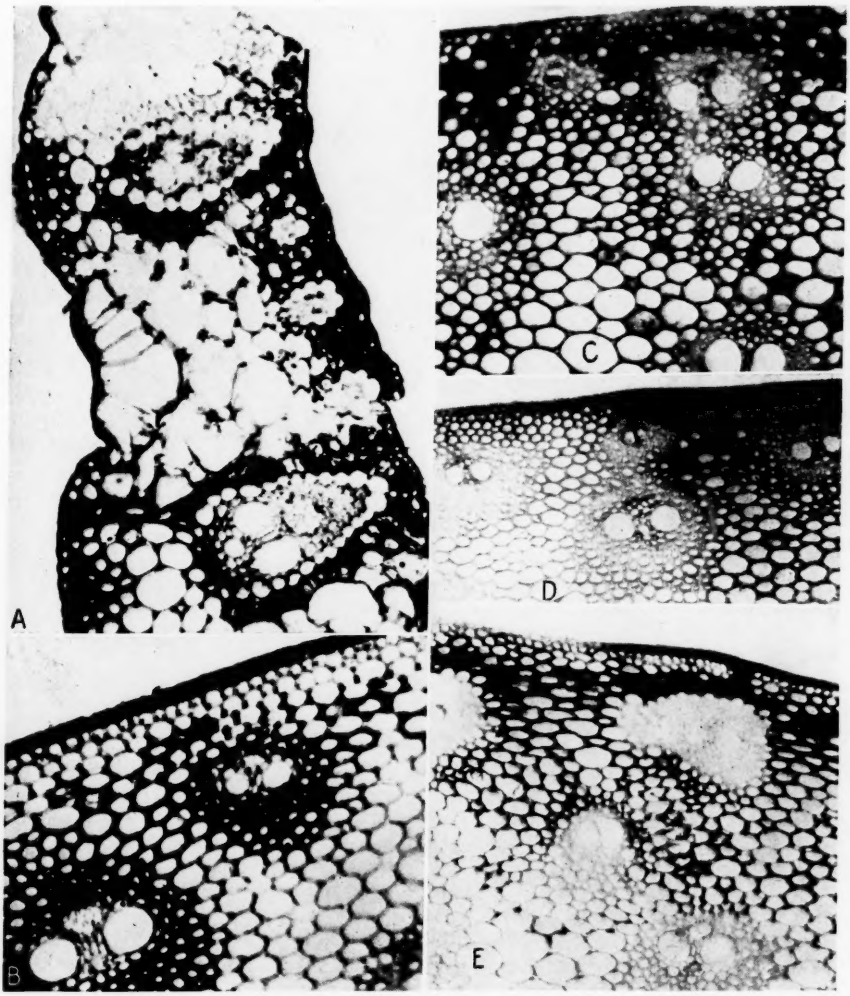
DEVELOPMENT OF STRIPE IN SHEATHS AND BLADE OF STRIPED UBA

Figure 5

A—Longitudinal section through a lateral bud. Isolated degenerating groups of cells show the beginning of a stripe 96×. *B* shows a nearly stage in the development of a stripe in a sheath. There is an accumulation of gum in the intercellular spaces and the cells lining the air cavity are dead 86×. *C*—Advanced stage of stripe in a sheath 109×. *D*—Young stripe in blade along the midrib. Parenchyma and bundle sheath of small bundles are dead, and many of the intereclular spaces are filled 92×. *E*—Section through a fully developed stripe. All the cells in the stripe are dead, normal tissue at extreme right 108×.

ing a sunken area at the surface (Figure 3*L*). The epidermis shrivels, dries, and the wax layer sloughs off. A cross section through one of these areas is shown in Figure 6*E*. The epidermis and a section of cells of the sclerenchymatous mantle are dead.

The blackened tissue is very hard, and



DEVELOPMENT OF STRIPE IN LEAF BLADE AND STALK OF STRIPED UBA

Figure 6

A—More advanced stage in the development of the stripe in a leaf blade. 134×. *B*—Early stage of development of a stripe in a stalk. Cortical cells only are affected. 148×. *C*—Section from older portion of the stalk, most of the parenchyma cells are dead, fibrovascular bundles are not affected. 87×. *D*—At right advanced stage of stripe, normal tissue at left. 87×. *E*—Transverse section through necrotic area from old internode of a stalk. Some of the epidermis and cells immediately beneath it are affected. Cortical cells have collapsed. 87×.

treatment with hydroflouric acid did not soften it; therefore, all the sections were cut freehand.

The dead tissue which forms the dark stripes is bacteriologically sterile. The death of the tissue can, for the present, be attributed to a somatic mutation. This mutation occurred in the somatic tis-

sue, because the striped clone arose from a vegetatively propagated clone of normal self-green Uba.

The striped characteristic is not permanent; however, the length of time it will endure is dependent upon the choice of planting material and the environment in which the plant is grown. Under field conditions in South Africa and at Canal Point, Fla., the stripes may be lost in a short time. In Africa the stripes do not appear until the cane is more than a year old, while in the original planting at Canal Point and in the greenhouse at Arlington Farm, Va., the stripes appear when the cane is young. Since the cane is cut every 12 months at Canal Point there is at least the probability that plants which appear to have lost the stripes might develop them were the cane allowed to grow for 18 or 20 months. A few stalks in the third stubble still have the stripes on the leaves. In the greenhouse at Arlington Farm, Va., the cane has come true to type for the past five years. During all this time one normal green stalk developed. Cuttings from this normal stalk produced normal plants, and cuttings from striped stalks have produced plants with striped stalks and a few normal plants. It is probable that lateral buds originating from the normal green tissue of a striped stalk produce normal canes. Under field conditions it seems that a larger proportion of normal green buds are produced and survive, consequently the stripe is soon lost.

The normal stalks from striped canes have not been studied sufficiently to know whether or not they will again produce the stripes. During the past few years the plants of this clone at Canal Point have produced all normal green stalks; however, a few stalks still develop the stripes on the leaves, which indicate, at least for the present, that most of the plants no longer carry the defect. If the necrosis is caused by a mutation that arose in a cell or cells of the meristem, then only these cells and those that are direct descendants of them are affected. It would appear, therefore, that normal green stalks produced by the striped clone will not produce striped canes unless the mutation occurs again. The normal green canes from striped Uba are like Uba and, perhaps, the frequency of the occurrence of necrotic stripes in them is no greater than in Uba. It is interesting to note that the first cells to degenerate in the stalk are the chloroplast-bearing cells of the cortex, and that in the leaf the chlorophyll-bearing bundle sheath is one of the first tissues to be affected. Whether or not the necrosis is a Mendelian character cannot be determined until a progeny is raised from seed of this clone. Stribed Uba has not flowered at Canal Point, and the probability that it will in the future is very remote because the clones of *Saccharum sinense* flower there infrequently.

The interest in Striped Uba was aroused by what appeared to be a somatic mutation producing a color variant. In the clones of *Saccharum officenarum* this would not have been anything unusual, because colored canes and striped variants occur rather frequently in this group, but in *S. sinense* all the clones are green, and no color variants are known. Therefore, a mutation in Uba giving rise to a cane with reddish-brown to dark-brown stripes would have been an unusual and interesting phenomenon. This investigation has shown conclusively, however, that the stripes are the blackened walls of dead cells, and that they do not represent a color variant.

Summary

The stripes in Striped Uba are composed of necrotic tissue. In the leaf the cells of the outer bundle sheaths are affected first, and finally all the cells between the lower and upper epidermis, and as wide as the stripe, die. In the stalks the first cells to die are the thin-walled chlorophyll-bearing cells of the cortex, and finally most of the parenchymal cells of the stalks are affected. The fibrovascular bundles remain alive and functioning even after all the surrounding cells are blackened and dead.

NUTRITION IN A EUGENICS PROGRAM

FAITH M. WILLIAMS
U. S. Bureau of Labor Statistics

IT is of the very essence of enlightened patriotism that we should be concerned about the quality of the persons who will be called "average Americans" a few decades hence. Eugenists have long emphasized the fact that the mental and physical abilities of one generation reflect the qualities of the parents of the preceding generation, due to the combined force of genetic and environmental factors. They are convinced that if science is to serve the purpose of developing a stronger, finer race of men, it must give increased attention to conditions affecting the origin and development of our children and youth. There is a new recognition that the same measures which have greatest immediate value for the development of child life may also profoundly influence the distribution of births in a eugenic direction.[9] This new recognition, which brings eugenics into closer alignment with other movements for social progress, springs from a deeper insight into the factors affecting family life, planning for children, and child development, made possible by rapid advance in many fields of scientific inquiry.

Nutrition is one of the most important environmental factors affecting human growth, and a subject about which recent progress in scientific information has been most rapid. Many aspects of the environment which, we know, affect the physical, mental or moral stature of the adult are extremely difficult to evaluate. We have only a very inconclusive evidence about the effects of different types of school training on children of varying abilities, of differences in recreational opportunities, of varying degrees of responsibility at given ages, or even of different types of housing.

We are, however, in a different situation as regards nutrition. Research in the field of biochemistry has proceeded so far that we now have very definite knowledge about the relation of diets and physical growth in childhood. Beginning with the work of Lavoisier in the late 18th Century, a vast amount of laboratory work has brought us to the point where we can be quite certain about human needs for certain types of food. The development was slow at first. Lavoisier established the relation of the respiratory process to food consumption in animals, but it was not until 1862 that Voit, a professor of physiology at the University of Munich, designed a respiration apparatus large enough to accommodate a man with comfort. This apparatus made it possible to measure the amount of oxygen used by a subject at rest, and while digesting different kinds of food. By 1880 enough work had been done with persons of different age and sex to make possible estimates of average energy requirements for all classes of the population. Concomitant studies of the energy supplied to average human beings by foods of different kinds made it possible to study actual family diets and to estimate to what degree these diets met the energy requirements of the cooperating families.

In the United States, interest in the science of nutrition was aroused by the work of W. O. Atwater, an American pupil of Voit who returned to this country to work at the Storrs Experiment Station in Connecticut and later at the United States Department of Agriculture. Most of Atwater's work was focused on studying the energy requirements of children and adults of varying degrees of activity and the nutritive content of the foods commonly consumed in this country. Atwater's scale of the relative energy requirements of adults and children was first published in 1886 and was widely used in this and other countries for a long period. Atwater himself

prepared a revision of this scale based on the laboratory research of the last years of the century. Later work in the field of energy requirements was summarized by H. C. Sherman and Lucy Gillett in 1917,[3] by the Interallied Food Commission in 1918,[8] by the Bureau of Home Economics in 1933[13], and by the League of Nations Health Organization in 1932.[1]

It is of considerable interest to the eugenist to observe that successive revisions of energy-requirement scales in this country since 1882 have brought the figures for children under two years of age to a considerably higher level than the scales now used in Europe. In fact, the scale of energy requirements recommended in 1932 by the International Conference of Experts (which was dominated by European scientists) shows a lower requirement for each age group up to six years than any scale ever commonly used in this country.[14] One must conclude that average American children are very much more active than average European children of the same age. (The caloric requirement of a man at moderately active work is taken as 100 in the case of both scales.)

Proteins, Minerals and Vitamins

Scientific studies of protein, mineral and vitamin requirements were much slower in bearing fruit than scientific studies of energy requirements because of the inherent difficulties of measuring human need for these nutrients. Rapid progress in our knowledge of needs for these elements in diet awaited the development of animal experimentation in nutrition. Work on protein requirements in general preceded the investigation of mineral and vitamin requirements. It has long been recognized that the protein requirements of children per unit of body weight is higher than that of adults. In addition, the character of the protein they eat is more important to growing children. For the full-grown man or woman, considerations of quality are not so pressing as for the young child, because in the case of adults we are concerned chiefly with the conservation of tissues already formed, and even an incomplete protein like zein of maize, inadequate for maintenance and incapable of supporting growth, is capable of protecting the body tissue to the extent of 73 per cent. For children a full quart of milk per day with its complete proteins (casein and lactalbumen), meets the needs for protein so well that other foods should be selected with reference to other equally important dietary factors.[10]

Systematic research on the exact nature of the mineral requirements of man has been going on in this country since 1910 and that on vitamin requirements since 1912. The need for more exact knowledge of the degree of human dependence on vitamins and minerals was dramatically demonstrated during the last war when deficiencies in the diets of many European children resulted in actual deformity. The work of J. Goldberger, L. B. Mandel, E. V. McCollum, H. C. Sherman and H. Steenbock and their associates in this country on the dietary functions of calcium, phosphorous, and iron in combination with the vitamins has been aided by the work of European scientists. In the period from 1932 to 1937, under the auspices of the Health Organization of the League of Nations, there were a number of conferences which brought together research workers in nutrition from all parts of the world. These meetings made possible an interchange of ideas, and discussion of techniques and results. The report of the Technical Commission on Nutrition of the Health Organization,[6] brings together in useful form the material on nutrition requirements about which there was general agreement at that time. Even in the interval since world disorder has made a continuance of these conferences impossible, notable developments have occurred in our knowledge of Vitamin *A* and of the Vitamin *B* complex.

Ideal Diets in Terms of Reality

In 1939 the Department of Agriculture published a valuable volume called *Food and Life* which summarized in readable form what is known about nu-

trition and human growth and health. An article in that volume by Stiebeling and Coons,[11] presents a table which gives specifications for diets which can be rated "good" for persons of different age, sex and occupation.

An analysis of the data presented in this table shows that the average child under two years of age needs about 30 per cent as many calories as his father (if his father is a man of average weight and height at moderate work), but he requires about 47 per cent *more* calcium, about 67 per cent as much protein Vitamin *C*, and about 75 per cent as much phosphorous and Vitamin *A*. Since the foods which supply the diet with little else but energy are cheaper per 100 calories than most of the protein foods, and those providing minerals and vitamins, it is obvious that an adequate diet for a child is much more expensive than his relatively small energy requirements would at first lead one to expect.

Comprehensive studies of food consumption in this country in the years 1934 to 1939 make possible for the first time an estimate of the distribution of the population by quality of diet. Using records of food consumption collected by the staffs of the Bureau of Labor Statistics and the Bureau of Home Economics, Dr. Hazel K. Stiebeling and her associates at the Bureau of Home Economics have analyzed the nutritive content of the diets of more than 5,000 families which provide data for a representative cross section of the entire United States. The analysis shows that about one-third of the families in the country had diets that must be rated poor. The details of the study are not yet available for all groups in the population, but they have been published in regard to the diets of employed wage earners and clerical workers from whom records of food consumption were obtained by the Bureau of Labor Statistics.[12] No families having been on relief in the year of the study were included, and no families with incomes under $500, so that these diets did not represent the U. S. minimum.

The diets as shown by these records were classified as good or fair if the uncooked food materials consumed furnished per nutrition-requirement unit at least the following quantities:

Specifications for diets rated good and fair by the Bureau of Home Economics; daily allowances of certain important nutrients per day for a 154-pound moderately active man.

Nutrient	Good diets	Fair diets
Protein: grams	67	45
Calcium: grams	0.68	0.45
Phosphorous: grams	1.32	0.88
Iron: milligrams	15	10
Vitamin A: International units	6,000	3,000
Vitamin B_1: International units	500	250
Ascorbic acid: milligrams	75	37
Riboflavin: Sherman units	600	300

Diets were classed as poor or in need of improvement, if per nutrition-requirement unit the raw food provided less of one nutrient than the quantity shown for a *fair diet*.

The analysis shows from 11 to 21 per cent of the white families in the several regions, and 11 per cent of the Southern Negro families were consuming food which, as uncooked food material, provided generous quantities of protein, calcium, phosphorous, iron, and vitamins *A*, *B*, ascorbic acid, and riboflavin. These included a wide margin of safety, probably about 50 per cent above average minimum requirements for protein and the minerals, and a wider margin, as much as two or three fold, for the vitamins. These generous margins provide not only for some waste in use but also for the higher than average requirements of some individuals and the fact that more than the minimum quantities of certain nutrients needed for growth or equilibrium appears to be advantageous.

In summarizing these findings, Stiebeling and Phipard estimate that there is little likelihood of a deficiency today in protein in the diets of many employed workers' families. Most of the diets furnished an adequate amount of phosphorous. Less than half, however, purchased food supplying as much as 0.70 gram or more of calcium per unit per day (a safe allowance), while about a sixth had diets furnishing less than the average mini-

mum requirement of 0.45 gram of calcium per unit per day. About half the diets supplied 15 milligrams of iron per unit per day (the amount for a "good diet"), and all but about 5 per cent, a "fair" allowance, 10 milligrams.

About a third of the families obtained diets high enough in vitamin *A* to insure good visual adaptation in semidarkness, and about a fifth obtained a liberal allowance. About half the families purchased foods which furnished less vitamin B_1 than the standard of the good diet for this nutrient. An abundance of vitamin B_1 promotes good functioning of the digestive tract. Acute deficiencies result in a disease of the nervous system called beriberi.

Somewhat less than half of the families secured the specifications of the good diet as regards vitamin *C* (ascorbic acid), a substance found in abundance in citrus fruits and tomatoes and in certain green and leafy vegetables and fruits, but almost 90 per cent had a "fair" allowance. Diets without sufficient provision of this nutrient result in increased susceptibility to infection, and in restlessness and irritability in children. An acute deficiency in vitamin *C* may produce scurvy, but other symptoms are more common in this country. Riboflavin (essential in the production of an enzyme involved in cell respiration and the energy metabolism of the body) was fairly well supplied by these diets. The pellagra-preventive factor was apparently amply supplied except in the Southeast, where the deficiency among the low-income groups is serious.

Deficiencies in the consumption of calcium and vitamins *A*, *B*, and *C* are readily understood when the division of actual expenditure is compared with recommendations for adequate nutrition at expenditure levels just above and just below the average prevailing in this group. Milk is one of the most important sources of calcium and of vitamins *A* and *B*. The relatively low proportion of the average allotted to milk and milk products is responsible in large part for these deficiencies. The deficiency of vitamin *C* is probably accounted for by the fact that actual purchases of green and leafy vegetables were considerably below those in the recommended diets. Stiebeling and Phipard found that "The chances for better diets increased with rising per capita expenditures for food. This was due chiefly to a more liberal use of milk, meat, eggs, leafy and green vegetables, and fruits, when more money was available."

Diets and Family Income

A number of other studies have shown the relationship between inadequate diets and low income. Perhaps the most striking example is Goldberger's study of pellagra in cotton mill villages of South Carolina which showed a progressively higher incidence of this deficiency disease as family income decreased.[4]

From the point of view of the eugenist, one of the most significant findings of the recent consumption studies is the effect of increased family size on food expenditures at the middle and lower income levels. These investigations have shown that at given income levels (at least until incomes of $7,500 are reached), the larger families spend less for food per capita than the smaller ones. The effect of increased size of family on food expenditures is shown by an analysis made by Lorimer and others using data collected by the Bureau of Labor Statistics and the Bureau of Home Economics in the Study of Consumer Purchases.[7] The data were limited to native white non-relief families including husband and wife, but no other persons over 16, in Chicago and three middle-sized cities (New Castle, Pennsylvania; Muncie, Indiana; and Springfield, Illinois) and a sample of comparable farm families in Pennsylvania and Ohio.

It was found that the proportion of family income spent for food increased as the size of family increased, but that actual expenditure and nutritional value per person declined. In Chicago, for example, standardized percentage expenditures for food increased from 34.7 for family type I to 41.6 for family type VI, for families with incomes under $2 000, and from 26.5 to 34.5 for families

with incomes of $2,000 and over. In contrast, however, standardized expenditures per meal per equivalent adult decreased for the families with less than $2,000 from $.211 to $.126 and for the families with $2,000 and more from $.292 to $.169. Detailed analysis indicated that in urban areas the average family with three or four children would need about twice as much income as an average family of husband and wife, to maintain the same level of living without sacrifice of other items. Actually, the increased expenditures for food necessary for larger, as compared with smaller families, resulted in a curtailment of a variety of expenditures, particularly for household operation, furnishings and equipment, transportation, gifts and taxes.

Education Needed

The problem of obtaining good nutrition for the rising generation, as well as for those who are now adults is, in part, a problem of educating the public to a knowledge of human food needs. In analyzing the diets of urban middle-income families (the employed wage-earner and clerical group mentioned above), Stiebeling and Phipard[12] found that, "At every expenditure level above a certain minimum, some families succeeded in obtaining good diets but others procured food only fair or poor, from the standpoint of nutritive value. For example, with an expenditure of $2.50 a person a week for food, 32 per cent of the families in East South Central cities bought good diets, while another 37 per cent obtained diets that were classed as poor." Nevertheless, even if every family were completely informed on the subject, 69 per cent of the white families and 74 per cent of Negro families in the group covered spent less than $2.50 a week per person for food.

According to the findings of the National Health Survey only 10 per cent of urban families with four children received incomes of $2,000 or more per year and only five per cent of the families with eight children, as contrasted with 17.4 per cent of the families with one or two children.[2] The importance from the eugenist's standpoint of this concentration of large families in the lower income levels rests in the obvious fact that for any income group the level of food consumption depends on the number of family members whose needs must be met by the amount available for food, and that food expenditures will also be influenced by the demands of the family for other items that make up the total budget.

Conclusion

Problems of nutrition have a two-fold significance for eugenics. In the first place, nutrition is a major factor in child development. In this way it is directly related to the environmental increase in human well-being, which is the essential corollary of eugenic progress. The scientific basis for marked progress in human nutrition has been established through research during the last few decades; but the social measures necessary for realizing this advance in the whole population are just now receiving adequate attention, giving hope that rapid progress in this field may be expected in the immediate future.

In the second place, food costs are a major component of the economic pressure which now operates so powerfully to prevent "responsible parents"—whose reproductivity is a principal concern of modern eugenic theory — from having enough children even to replace the parent stock. Thus in Chicago among families with incomes of $1,500 to $2,000[5] with three or four children under sixteen but no adults except the father and mother, expenditure for food makes up 40 per cent of all money expenditures. It has been shown that as the number of children in the family increases, there is a marked increase in the proportion of money outlay devoted to food, but at the same time a significant decrease in the nutritional level which the family (even with much sacrifice of other interests) is able to achieve. The eugenist, therefore, has a vital concern in the advancement of social measures for the furtherance of nutrition, and a special interest in mak-

ing sure that the measures adopted will be of such character that they will express the interest of society in the family and children, and will actually contribute toward making it possible for parents who want reasonably large families to fulfill this desire without lowering the level of family living at vital points either for themselves or for their children.

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Age of Mother and Mental Defect

We are familiar with the well-known fact that many children of the lower mental grades (the Imbecile and Idiot groups) are derived commonly from normal parents and are classified as "accidental" cases. Children in the Dull Normal classification also are found to have Normal parents quite commonly. On the other hand, children of the Moron group are diagnosed as "Familial" quite frequently and the condition considered due to an inheritance of mental defect from the parents. The same may be said of a portion of the children in the Borderline classification. It would appear that the older age of the mother at the birth of the child is of greater significance in the children of normal parents than in the children of mentally defective parents.

While the evidence is far from conclusive, we have the suggestion that the non-hereditary forms of mental defect may be linked with the older age of mother at birth of child. Mental defect which has been inherited stands in a half-way position. It shows some degree of linkage with older age of mother, but the influence of this factor is not as great as in children of Normal parents. In all mental status groups below Normal, the older mothers have a greater chance of the condition appearing in their children than the younger mothers. Older age of mother is an unfavorable factor in all levels of retardation but is of greatest importance in the Dull Normal and Imbecile classifications.

The material presented offers a plea for early marriage and the completion of childbearing before the mother is 35 years of age.—NIEL A. DAYTON and BERNARDINE TRUDEN, *Amer. Jour. Mental Deficiency,* October, 1940.

PARENTHOOD ATTITUDES OF COLLEGE MEN

CHARLES PUGH DENNISON
St. Andrew's School, Middletown, Delaware

AS births become decreasingly a matter of physiology and chance, the motives which induce human beings to beget and rear children assume an increasingly important role in determining the relative rates at which the various sectors of our population will reproduce. Since college men, whose birth rate is considered to be of particular social significance, are notoriously slow to replace themselves, the attitudes of this group are of considerable importance in the development of a better balanced pattern of births. This study of the families of Princeton men has been made to determine the relative importance of the various psychological factors which have operated to limit the size of their families.

The material for this study was obtained by questionnaire through the cooperation of more than 400 members of the classes of 1900, 1902, 1912, 1913 and 1921. The questionnaire contained inquiry as to the family size the graduates considered ideal "if all conditions relating to rearing children were favorable," a checklist of reasons for failure to attain this ideal, and another such list of possible reasons for having children. Other blanks to be filled, for purposes of dividing the group into more homogeneous subgroups, included questions on their occupation, income, religious affiliation, number of children, and the size of their parents' family.

Although the study was primarily a statistical one, much of the information gleaned from the questionnaires was found to be more meaningful as qualitative data; therefore, the first part of the discussion will be an interpretation of our quantitative findings in the light of other information submitted which could not be treated statistically.

The Composite Picture

The average Princeton graduate with whom we are dealing is a man to whom the companionship of a family is one of the blessings of life. Rarely has he been soured by experience into the state of mind in which new life does not seem worth bringing into a world like this, though this view is not unheard of; and *never* does he believe in having just one child. He usually wants four, or at least three, given the means to rear them. Granted that all circumstances ideal for child-rearing are available, a professional man is likely to want a larger family than a business man, though a teacher will be less likely to feel this way than other professional men. Those who incline most toward large families are the clergy, who tend to consider parenthood a social obligation more than do others. Correspondingly, a man professing religious affiliation will be likely to want more children than one who considers himself agnostic or atheist.

The parenthood attitudes of this average man are part of a whole pattern of values, of which he may not be conscious. Before parenthood, he looked forward to the companionship of his offspring more than to the prospect of continuing his family line, though the latter idea was in his mind as a second thought. Over a period of time, a complex of attitudes about his children has formed, which makes it difficult or impossible for him to give, as so many separate reasons, his motives for having children. He may think he knows the reasons, but when he is asked to state them, he is unable to give the same ones as he would have given before the children were born.

If he does not feel able to give well-

defined introspections, he may attribute his motives to some blanket mystical force, such as

"an instinct which causes him to want children and love and sacrifice for them."

This force may be described by him as

"an instinct which becomes falsely represented if you try to confine it to words."

He may, moreover, place parenthood in his system of philosophical values.

"None of the dumb cluck reasons for having children seem to say anything. We had children because we wanted children—not for the 'companionship of *young* children'; children don't stay young—nor for companionship in old age, which may never happen. Married life is incomplete and life impoverished without children. What number do you put that under?"

Answers such as this last one must be translated to the psychological level before they take on any meaning. The principal point to be grasped from them is that the desire for offspring is often, if not usually, a part of a whole *gestalt*, which the individual lacking in scientific expression is unable or unwilling to analyze. The following case is comparable:

"For a variety of reasons, sociological, psychological and physiological, human life remains imperfect without the association of the sexes implied in marriage; in addition to which, marriage in its total potentialities remains unfulfilled without the normal complement of children."

The Results in Figures

From the checklists of reasons for having children, and for failing to have more, certain reasons were widely accepted. The position that these men were not on the whole interested in children is excluded by the fact that only 5 per cent of them admitted no particular liking for children, and also by the fact that only 29 per cent of those whose families were completed (i.e., the class of 1913 or earlier) claimed to have attained their ideal number. On the whole, they would like to have an average of 3.9 children, or 1.5 more than they have.

The failure of the actual family size to equal the ideal number was accounted for chiefly by the four reasons which follow, in order of their frequency of appearance in the responses:

1. Limited financial means (in any respect) 57%
2. The physical hazards of childbirth.. 32%
3. The trials and restrictions of parenthood 24%
4. Inability to have more children 23%

The other three reasons offered were checked in not more than 10 per cent of the answers in question. These reasons were:

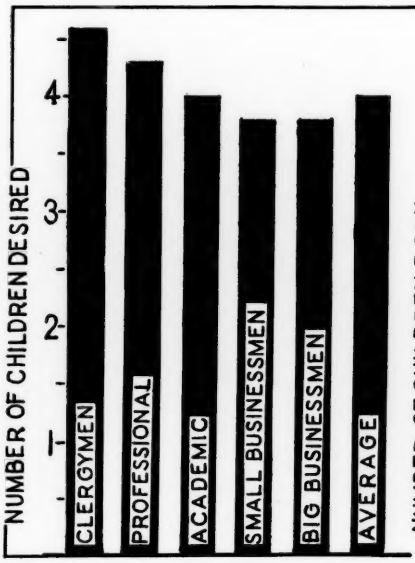
5. Childbearing postponed because of vocational and other interests..... 10%
6. Any marital problem..... 9%
7. Lack of any particular liking for children 5%

By allowing graded responses, we noted one or two significant reversals in this tabulation. Although the inability to have more children was mentioned less frequently than the "trials and restrictions of parenthood," it was more often given much importance than was the latter reason. It must be noted that these reasons are not mutually exclusive: very few people were able to give *the* reason why they had fewer children than they considered ideal. Medical reasons alone probably account for not more than 25 per cent of the discrepancies between the ideal and the achievement.

Concerning the positive aspect of motivation, nine items were placed on the checklist. The most important turned out to be the following, in order of the frequencies with which they were checked:

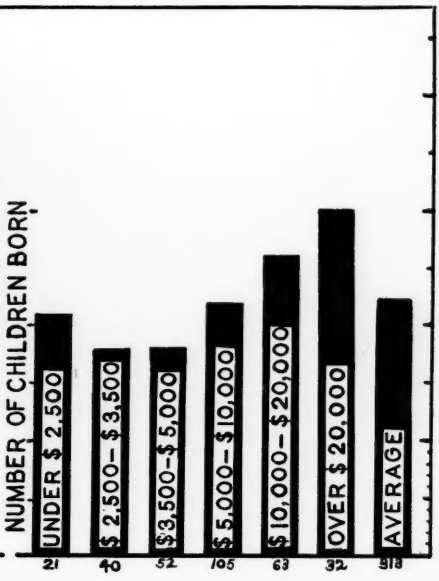
1. The companionship of young children 82%
2. Perpetuation of the family..... 66%
3. The creation and development of new life is one of the main interests of living 63%
4. The desire for a real embodiment of the ideal relationship between the parents 59%
5. Companionship in old age 48%
6. Fulfillment of a social obligation 40%
7. The idea of having children is accepted as a social convention 35%
8. Birth occurred in spite of some prevention 15%
9. Opposition to artificial prevention of births 7%

One significant reversal in this order of frequency occurs when these reasons are ranked according to the number of times they appear as of "much importance." Although "perpetuation of the family" is second in frequency, "the crea-



WHAT THEY WANTED
Figure 7

Size of family considered most ideal, according to general occupational groups. Religious conviction and occupation affected the number of children desired. This distribution is an answer to the question: "If all conditions relating to the bringing up of children were favorable, what number of children would you consider ideal for a family?" "Professional" includes doctors, lawyers, etc.; "Academic," teachers and research men.



WHAT THEY HAD
Figure 8

Average number of children, according to earned income. All men in this tabulation earned all or most of their income. The numbers at the bottoms of the columns give the totals in each group. This group is not exactly the same as the group charted in Figure 7, but the overlap is great enough to serve as a valid contrast between desire and fulfillment, for the average number of children of all those who answered the questionnaire was 2.4.

tion and development of new life . . ." is more often given much importance than is the former reason. On the basis of checks in the "much importance" column, "Perpetuation of the family" is only the fourth most frequent in appearance. In view of the difficulty many answerers had in confining themselves to rigidly stated reasons, the implication of this reversal seems to be that "the creation and development of new life. . ." is the more potent factor.

Another fact to be mentioned is the tendency of "companionship of young children" to be of less importance for men who married after the age of 32, or whose wives married after the age of 30, than for the average.

Having given the relative importance of the various reasons for the group as a whole, we may raise the question, "What kind of people give what kind of answers?" These cases are all college men, but college men can be as different from one another as they are from street cleaners (perhaps the two groups will be found to overlap). Do a professor, an engineer, and a business man all have the same reasons for bringing up a small family?

Occupational groupings did tend to give somewhat different answer patterns. With respect to the question on their ideal family size,* the figure given by

*"If all conditions relating to bringing up children were favorable, what number of children would you consider ideal for a family?"

business men was lower on the average than that given by clergymen or teachers (see Figure 7). This fact may mean that business men do not tend to think in terms of the "ideal," that business life is not conducive to interest in a large family, or even, conversely, that people who do not want to rear a large family tend to enter business as a career.

Religious values were found to affect this ideal number, men identified with a church averaging a higher ideal number than agnostics, atheists, and members of similar groups. Church members averaged 4.0 in this respect, whereas others averaged 3.5.

While there is no significant difference, according to income, in the family size considered *ideal,* those whose incomes are higher do tend actually to have more children than those whose incomes are low. Figure 8 shows an increasing average birth rate with increasing income (earned income), the reversal in the trend probably having been caused by the paucity of cases from the lowest income group.

Thus, though the ideal number of children does not vary significantly among the various income groups, the actual family size does tend to vary according to income. This fact lends force to the previous statement that "limited financial means" was credited as the most important reason for restricting family size. It also confirms J. J. Osborn's report* on a related study, that the more able college men tend to have more children than the less able. The assumption here involved, that higher earned income reflects greater ability, is naturally made only statistically, and bears no reference to individual cases. It assumes only that, of a whole group of men, those who earn more money have a higher *average* ability than those who earn less money, *all other factors being equal.*

The question regarding what family size seemed ideal brought responses revealing varying degrees of self-analysis, and different life values, which suggest that, if we had more cases at our disposal, we could subdivide them into more homogeneous groups and find more pronounced differences. Perhaps, subsequently, when more extensive studies are made, professional men should not be identified as a homogeneous group whose attitude is to be considered collectively. A manufacturer may, after all, have more tendency to think like an engineer (a professional man) than like a broker (another kind of business man). If a larger study should, instead of contrasting the attitudes of professional men with those of business men, base the comparison on a division of the group into city dwellers, rural dwellers and commuters, the differences among the opinions of various groups might be more pronounced.

Similarly, we may speculate as to whether the reactions of teachers in this respect would depend on whether they were college or school teachers. In other words, to summarize the question just raised: although in this preliminary study we tried to choose points of external difference most conducive to different attitudes toward the problem, we still lack statistical assurance that the color of a man's eyes, for example, affects his parenthood attitudes less than do his religious values.

The average ideal number we found may be higher than it would have been if we had received 100 per cent reply to the questionnaire, though not enough higher to mar the conclusion that members of the group questioned would like the opportunity to rear more children than they have. Large families tended to be heard from more frequently, in proportion to their actual number, than did families with less than three children. The true average family size of the whole group we already knew to be 1.9*; those who answered the questionnaire average 2.4. Also, the more successful graduates were slightly overrepresented, according to the number of answerers in *Who's Who,* as against the

*Osborn, J. J. Fertility Differentials among Princeton Alumni, *Journal of Heredity* and *Eugenical News,* December, 1939.

number thus distinguished who did not answer. Other more subjective evaluations of success, embracing most of the members of the whole group, yielded a similar indication. The number held as ideal, however, was so consistently greater than the number achieved, even in the smallest subdivisions of the main questionnaire group, that the qualitative conclusion does not seem to be threatened. Most of these parents, granted favorable circumstances, would like at least one child more than they have.

Objectivity of the Answers

Although most of the answerers seem to have had clear reasons for restricting family size, a lack of definiteness was displayed by many, who checked at least five or six of the nine reasons offered as motives for having children. Others found their attitude too unique to be classified and, instead, wrote a paragraph commenting on the "instinct" which motivated them, apparently being perfectly satisfied with something mystical which defied analysis.

One instance of unconscious rationalization was apparent among those who gave "much importance" to "the desire for a real embodiment of the ideal relationship between the parents."* Although this was fairly popular as a reason, *not once* was it given "much importance" by a childless couple. It follows that, since nobody should know better their reasons for having wanted children than those who still want them, "the desire for a real embodiment of the ideal relationship between the parents" is a rationalization which appears after parenthood but probably is not important in inducing parenthood.

Another indication that checklist items are too suggestive to prompt an accurate introspective report was seen in a trial item included in an earlier "sample" questionnaire. This item, that "childlessness may some day be cause for regret," was checked by 33 per cent of the husbands; yet, when it was not included in the questionnaire, nobody volunteered supplementary information indicating this motive. The resulting implication is that suggestion is an important factor in such introspective questionnaires as this one.

Since all of nine reasons might be related to a person's motives, as he sees them, without actually coinciding with any of these motives, we have taken our quantitative findings as abstracts of the real motivational patterns in question, which have been blended into the composite picture preceding the discussion. Any measurement, of course, is a doubtful quantity when what is being measured is a doubtful quantity, and subjective reports of human motivation are doubtful quantities.

This study is admittedly a preliminary survey of a comparatively new field, a field in which more information is needed, about each individual studied, than a questionnaire mailed for voluntary reply is likely to bring. Larger studies, with more comprehensive knowledge of each person in question, may introduce the refinements of method suggested in the discussion.

*This item, intentionally emotional and non-analytical, was included because of a comment, offered on a sample questionnaire, that the reasons we proposed were all too "cold."

EUGENICS AND FAMILY RELATIONS

PAUL POPENOE
American Institute of Family Relations, Los Angeles

DURING the past decade, the ideas loosely gathered under the name of "family relations" have become a more and more important part of American education and even of American thought. The family relations movement promises to provide the strongest assistance which eugenics has yet received in its task of creating a sound public opinion.

The term "family relations," is now used to describe many high school and college courses, applied to many institutions and organizations and employed by innumerable writers and speakers. Though it varies in its connotations, in a general way it has to do with the promotion of successful marriage and family life. Obviously, this development strengthens the eugenics movement on the positive side.

It is probably fair to say that most of the identifiable eugenic progress in the United States during the past generation has been on the negative side, in bringing about a reduction of the birth rate in homes that can give children only a bad start in life—homes that can provide them with the fewest advantages in hereditary endowment, in health, education, and ideals. Twenty-nine states and one territory (Puerto Rico) now have laws providing for the sterilization of certain persons who are mentally defective or mentally diseased. The wider spread of contraceptive information and increased distribution of contraceptive materials cuts off some lines of descent that carry a disproportionate number of defective genes. The rapid adoption in recent years of state laws requiring a delay before a marriage license is issued, and demanding a physical examination, doubtless also helps indirectly to prevent dysgenic marriages, even though the purpose of such legislation is not primarily eugenic.

Such measures are simple and understandable; voters are easily able to recognize the results to be attained. On the positive side of the eugenics program, where measures are needed that will increase the birth rate in homes that can give children a good start in every way, there are no similar measures that will produce immediate and visible results. The steadily decreasing birth rate in the educated part of the population is the consequence of intricate and interrelated factors, partly educational in the broad sense of the term and partly economic. Often these factors can not be disentangled even in research, much less modified by any specific legislation.

Earlier eugenists hoped to get positive results by convincing people that it was their duty to have children. Francis Galton looked forward to the time when eugenics would become a kind of religion. It is now clear that such motivation for parenthood is not adequate at the present time. "Good intentions" are crowded out by the pressure of public opinion and of economic realities. Most people, however, are susceptible to an appeal based on their own happiness. In fact, it is not even necessary to tell most intelligent people that they will enjoy life more if they are happily married and are successful parents. They start with that postulate. All that is necessary is to show them *how* they can marry happily and be successful parents. The general purpose of family relations education is to show how this estimable and eugenically most important ideal can be realized.

1. Guidance in the Choice of a Mate

In everyday life, mate selection is not based consciously on eugenic considerations, but eugenists have always recognized that many of the qualities which make a mate attractive are genuine eu-

genic qualities. Most people prefer to marry into "a good family," and to marry a partner with good health and intelligence. The main obstacles to better mate selection in American society today are probably the lack of an adequate range of choice and the complex of Romantic Infantilism so persistently encouraged by the movies, by novelists, and by radio broadcasters.

Both of these obstacles are being attacked today more vigorously than ever before. Schools, churches, community organizations and the young people themselves are striving to provide youth with a more normal social life, not merely as a pre-requisite to satisfactory mate selection but because it is essential to good mental hygiene in any case. The social life of students in high school and college had deteriorated so much that, as revealed by studies in different sections, a few students had more social life than was good for them, while half or more had virtually none, even in coeducational institutions. Measures are now widely adopted to remedy this.

The infantilism which looked on "love" as merely a mysterious visitation, which made the intensity of one's subjective sensations the only criterion of the validity of this "love," and which justified any sacrifice involved in the gratification of what was actually only self-love—this, too, is under fire from all sides. The spread of modern ideas of mental hygiene has made it more and more difficult for anyone to defend this type of infantilism seriously. To say that it is losing ground may be too optimistic, but it is certainly on the defensive.

The problem is wholly educational—again using this term in its broadest sense. One of the main stumbling blocks in the way of those who would substitute a biologically and ethically sounder idea of love is the English and foreign literature departments in the schools, which cling to such adolescent and neurotic patterns as *Romeo and Juliet* and *Lost Horizon*. As long as literature is a compulsory subject in education, it should be in the hands of those who are capable of interpreting it intelligently to young people for the guidance of their own lives. Family relations education is given so far mainly in the departments of home economics, physical education, religious education, psychology, biology, and social science, but in time it may influence even the traditional content of the English course. If so, the eugenic gain will be considerable.

Among the commonest problems in mate selection, which are continually raised by young people, are those related to differences in age, education, and religious affiliation, together with the ever-present economic difficulties. Questions of genetics appear rarely, because the public has not been taught to think genetically. Whenever such a question is raised in a group of young people, however, it is likely to arouse interest—an indication that youth is not behind its elders in its concern, or at least its curiosity, about heredity.

In general, however, it can be said that young people have high standards of what would be a desirable choice of a mate. If they do not put these standards into effect, it is often merely for lack of opportunity, because their range of acquaintance is so restricted.

2. Help in Starting Marriage Successfully

It is still too soon to say whether the many good courses in marriage and the family now being given in the schools are actually helping students to enter marriage successfully. To get any statistical evidence will always be difficult. It can at least be said that the students themselves express great satisfaction with these courses—excluding a few perfunctory offerings still given by unqualified persons who take refuge from reality by a flight into history. Some instructors feel more sure of their footing if they keep back among primitive peoples; others recognize the Industrial Revolution as a danger line and become uneasy if the discussion of home life gets this side of the eighteenth century. One instructor reported complacently, "We give the first six weeks of the course to a discussion of the *definition* of the fam-

ily." It is fair to add that such courses are being superseded rapidly by more functional approaches.

The American Institute of Family Relations, now completing its eleventh year of activity, has contributed what it could to instructors giving such courses in schools, colleges, churches and community organizations. Young People's Christian Associations and Hebrew Associations and similar groups in almost every state are sponsoring discussion groups in this field. Staff members of the Institute have participated in many of these undertakings and have spoken in more than 200 colleges and universities.

In a more limited and intensive way, the Institute offers a "premarital service" in its Los Angeles office, which provides special help to those who are about to marry. This includes a study of the personal and family history and the personality, and a full educational preparation, together with a physical examination. The Institute is a bit proud of the record this service has attained, for every couple that has taken it is still married—a creditable achievement in a country where more than one-half of all marriages end in divorce.

The most widespread help at this point is now being given by clergymen, more and more of whom are taking advantage of the opportunity to see that the young people whom they marry have some knowledge of what they are doing. Since three-fourths of all marriages in the United States are performed by clergymen, their general participation in the attempt to promote successful marriage will be far-reaching. And it goes without saying that eugenic progress is dependent on successful marriages, among other things.

War and family life never get along well together, and the United States has had its most recent reminder of this fact in the increase of weddings, amounting in some states to as much as fifty per cent more than usual, which preceded the introduction of selective service. No one seems to know just why so many young people suddenly rushed into marriage. Doubtless the factors were numerous and interrelated. Often such a marriage represented the culmination of a long acquaintance and betrothal. The young people had been waiting for times to get better, but now decided it was not worth while to wait any longer. The future was too uncertain; they might as well make sure of what happiness they could. A marriage of that sort might turn out as well as any other. To the extent, on the other hand, that these marriages represented war hysteria, short acquaintance, and less deliberate choice, they will be handicapped, will need all the more help in the future, and at best are likely to be of doubtful eugenic value.

The disturbed and rapidly changing conditions that seem likely to exist in America during the next few years will demand a corresponding increase in education for marriage and assistance to those already married if family life and its associated eugenic interests are to be safeguarded.

3. Help in Staying Married

Since the marriage rate has been increasing for many decades in the United States, it is evidently not the mere lack of weddings that hinders eugenic progress. Broken marriages contribute fewer children to the next generation. From two-thirds to three-fourths of all divorces are childless, although they have been married for ten years in the average case before they got to the divorce court.

To some extent the divorce mill terminates undesirable marriages and allows the superior party, if there is one, a chance to make a second and more desirable marriage. Many divorcees are, in fact, biologically inferior, as shown by their short expectation of life, their high degree of childlessness, and their great expectation of suicide and of commitment for crime or insanity.

Divorce as a means of terminating a eugenically undesirable marriage will be less important in proportion as people marry more wisely in the first place. Beyond this, its value in allowing a second and better mating is diminished by

the probability that the woman in the case will not remarry. Her age tells against her and the proportion of divorced women who ever remarry may not be more than one-third.

Whatever eugenic value divorce may thus have in special cases, it is obvious that many of the 250,000 divorces which are now granted yearly are undesirable from every point of view and that they result in the breaking up of homes which, if kept intact and made more successful, would have contributed valuable children to the community.

If it is hard to believe that the steadily mounting divorces represent a clear eugenic gain, it is doubly hard to imagine that the increase in divorce among college graduates is an advantage in any way. College graduates represent a selected part of the population in health, ideals, intelligence, and parental background. While the divorce rate of college graduate men has remained about the same for a long time, the federal Office of Education has recently published the unwelcome news that the divorce rate of college graduate women is now four times that of the men and is rising steadily.

In many cases the provision of help to superior persons who are having marital difficulties will enable them to establish the home on a firm foundation and to contribute children from it. The counselling services which have been a part of the family relations movement have therefore a real eugenic value, merely by enabling people to make their marriages successful and permanent. Most of the counselling is done through mental hygiene clinics, child guidance clinics, birth control clinics, social hygiene associations, social work agencies, and through clergymen, physicians, lawyers, teachers, organization executives and others who are more or less obliged to counsel as part of their work. Most of the counselling will continue to be done through these channels, and the American Institute of Family Relations helps many such persons to become more proficient technically, in addition to conducting its own Department of Personal Service for counselling. There is indication that, when financial support is offered, special agencies in this field will increase.

4. Help People to Have Children and Rear Them Well

In the educated part of the population most of the childless marriages are voluntarily so. (This is not true in lower socio-economic levels.) In some marriages, a little skilled help will remove sterility; in others, education may lead a couple to have children, or more children. Occasionally a couple, worrying needlessly over the possible transmission of an undesirable trait, can be reassured and encouraged to undertake parenthood. At other times they may be aided by advice in budgeting.

After the children are born, help is still necessary to enable them to be reared in a wholesome atmosphere. If they are brought up with the wrong kind of mental hygiene, they may be incapable of successful marriage. Their chances of satisfactory marriage are also reduced if they grow up in an unhappy or broken home. If two persons marry, each of whom comes from an unhappy home, their chance of success in their own venture is almost fifty per cent less than if both came from happy family backgrounds. Here again they need special help, as does the "only child," who carries a handicap of about twenty per cent in marriage.

Help to parents is now almost universally available in the United States, not merely through some of the special agencies I have mentioned but through parent education, magazines and newspapers, and the National Congress of Parents and Teachers. The eugenic bearing of all this, while not direct and immediate, is none the less real and valuable.

5. Finally, the Whole Community Needs to Become Family-minded

Eugenic progress is slow indeed where family life is deprecated, celibacy exalted, motherhood regarded as a misfortune and children as a nuisance. Under the

impact of the Machine Age, city life in the United States went surprisingly far in that direction, but the pendulum is now swinging back. One of the forces that will continue this swing is education in family relations throughout the nation. Such education is not limited to any one channel or any one subject. It is a broad and well-rounded approach.

The public education carried on by the American Institute of Family Relations may serve as an illustration. In addition to pamphlets, books, lectures and radio programs, the Institute has particularly adopted the all-day conference (sometimes actually lasting two or three days) as a technique in adult education. Its one hundredth such conference was presented on October 4, 5 and 6, 1940, in Los Angeles. Not only in California, but in such widely scattered states as Arizona, Colorado, Connecticut, Louisiana, Michigan, Ohio, Pennsylvania, Texas, and Wyoming, these conferences have enabled the Institute's staff to collaborate with local authorities in reaching the public.

Usually such a conference includes a number of addresses and a series of round-table discussion groups, often as many as fifteen or twenty. In this way the public can hear its own questions discussed and, if possible, answered by experts. Such education becomes direct and specific, and the distinction between group education and personal counselling thus tends to become less and less important.

Eugenic advance depends, of course, on having a community which is not merely family-minded, but discriminatingly family-minded. It is not enough to respect motherhood and fatherhood: some parenthood is really not respectable! If family life is to be admired, it must also be supported. A board of education, for instance, cannot praise marriage and family life consistently when its policy is to discharge every woman teacher who marries.

The spread of interest in family relations will naturally be a foundation for public action to strengthen family life in every possible way — not merely through such more obvious channels as those mentioned above, but through public health, recreation, social work, and economic legislation, to the end that more children be born in good homes and fewer children in bad homes.

The family relations movement has had the advantage of all that eugenists did for a quarter of a century before "family relations" became a familiar expression in the classroom and on the street. Much of the foundation for this new movement was laid in the writing and speaking of students of eugenics. Though the family relations movement is not ostensibly based on eugenic considerations, I believe that it contributes something to the spread of negative eugenics, and contributes more to positive eugenics than is to be had today from any other source.

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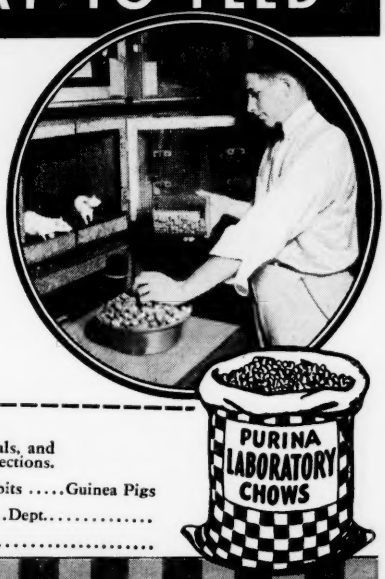

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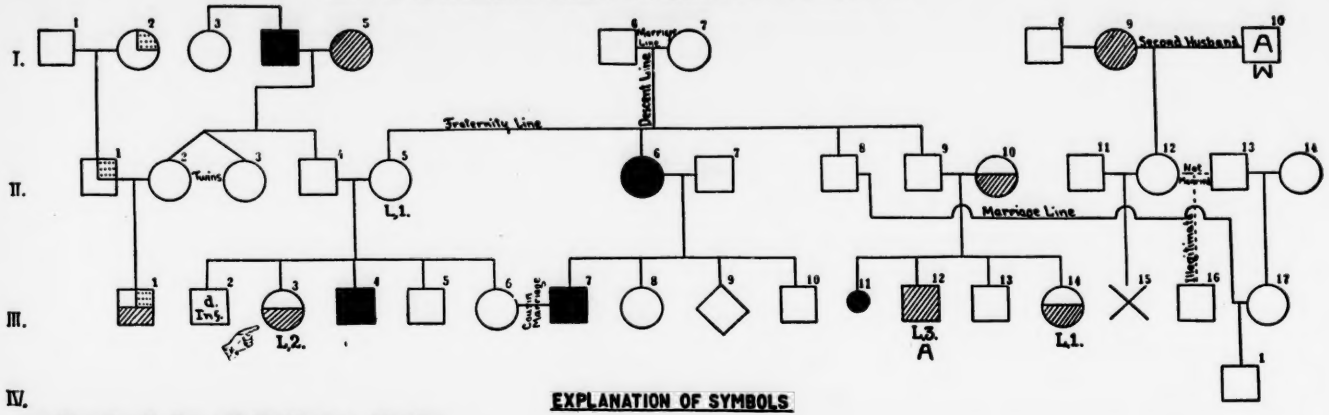

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(a). Standard for all Pedigree Charts:

□=Male; ○=Female; ◇= Sex unknown; ●= Still-birth or Miscarriage; X=Children — number and sex unknown; ○○ = Twins; d.Inf.=Died in Infancy; ☞ Points to the Propositus or central figure in the pedigree.

□—○ = Parents.

□○□○○=Children.

Roman figures to the left indicate generations; Arabic figures locate individuals, (thus III.7 is the young man in the third generation who married his cousin).

The following letters, placed in or around the individual's pedigree symbol, are standard for certain traits: A, alcoholic; B, blind; D, deaf; E, epileptic, F, feebleminded; I, insane; M, migraineous; N, normal in reference to traits under consideration; Ne, neurotic; P, paralytic; Sx, sexually immoral; S, syphilitic; T, tuberculous; W, wanderer.

(b). Especially devised or selected for this particular pedigree-chart:

■ ● = Successful leaders in politics. ◳ ◷ = Extra thumb on right hand. L.1.= Highly successful author. L.3.= Little or no ability in literary efforts. ▨ ◍ = Superior in vocal music. ▨ ◍ = Medium attainment in vocal music.

To fit the particular family and traits (whether physical, mental or temperamental; good or bad) under consideration, invent special symbols, or select special letters (in addition to those standardized under (a) above) to be placed within or near the particular individual's pedigree symbol, to indicate particular traits and their degree of development.

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